Java Semaphore Usage Considerations

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Learning Objectives in this Part of the Module

- Understand the concept of semaphores
- Be aware of the two types of semaphores
- Note a human known use of semaphores
- Recognize the structure & functionality of Java Semaphore
- Know the key methods defined by the Java Semaphore class
- Learn how Java semaphores enable multiple threads to
  - Mediate access to a limited number of shared resources
  - Coordinate the order in which operations occur
- Appreciate Java Semaphore usage considerations

Java Semaphore Usage Considerations

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- Semaphore is more flexible than the more simple Java synchronizers

Synchronized Statements

Another way to create synchronized code is with *synchronized statements*. Unlike synchronized methods, synchronized statements must specify the object that provides the intrinsic lock:

```
public void addName(String name) {
    synchronized(this) {
        lastName = name;
        nameCount++;
    }
    nameList.add(name);
}
```

Class ReentrantLock

java.lang.Object
    java.util.concurrent.locks.ReentrantLock

All Implemented Interfaces:

Serializable, Lock

Java Semaphore Usage Considerations

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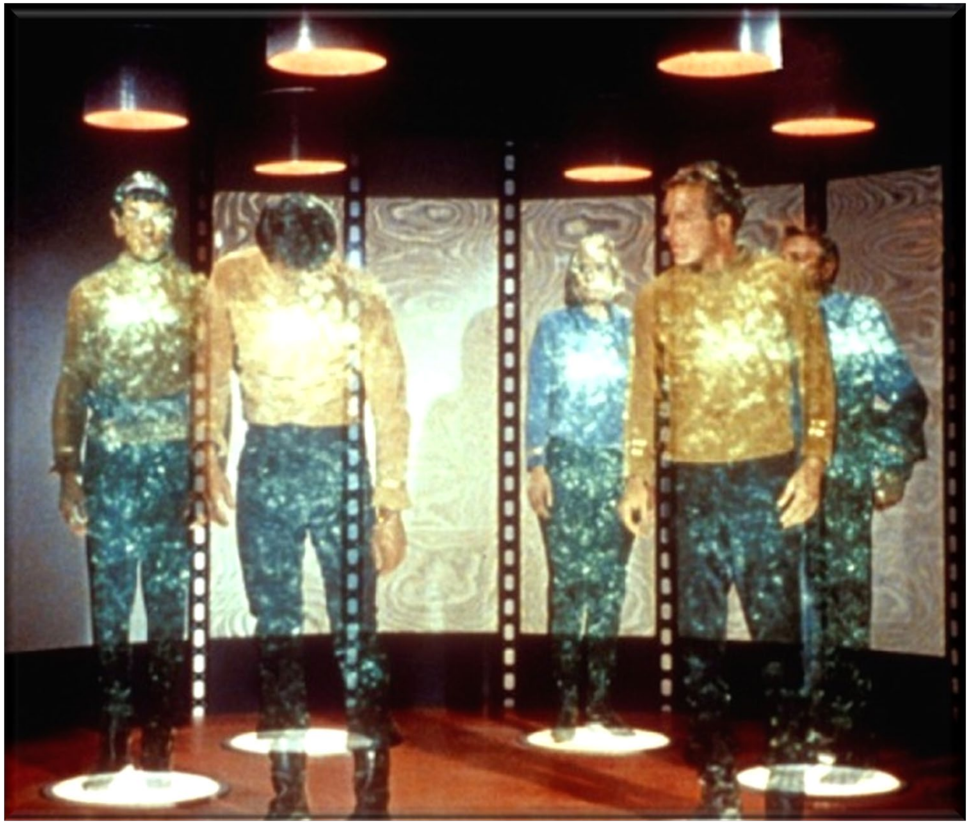
  - Can atomically acquire & release multiple permits with 1 operation



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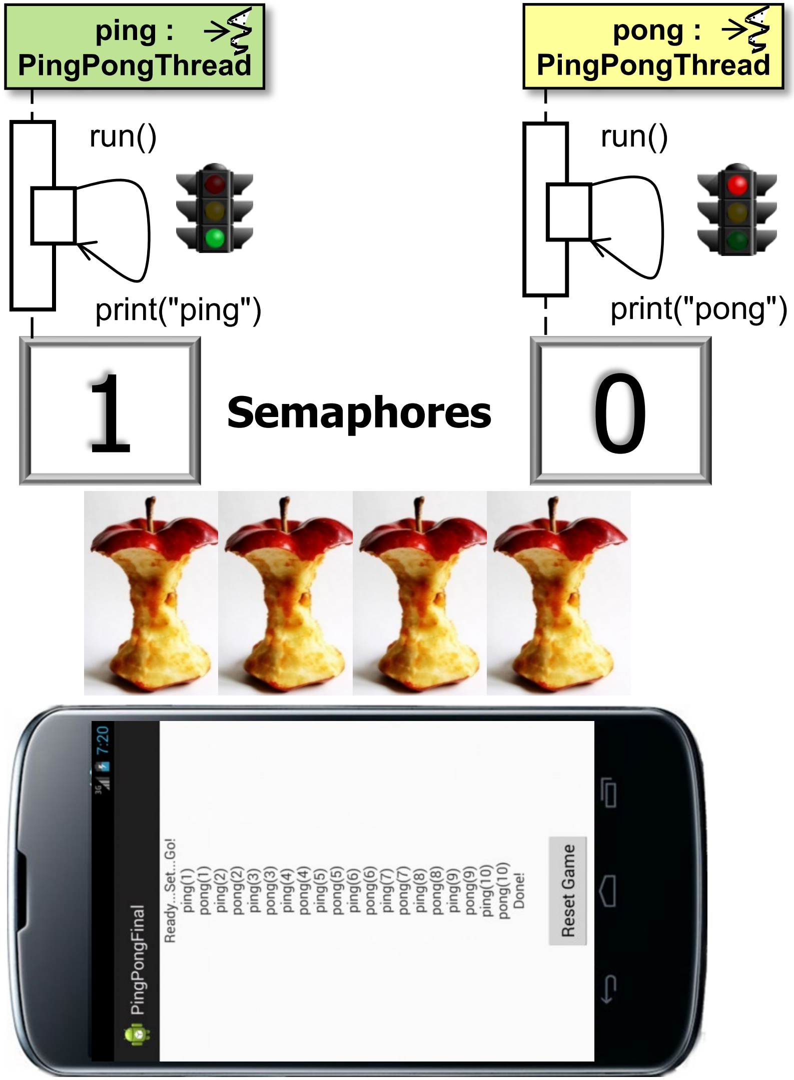

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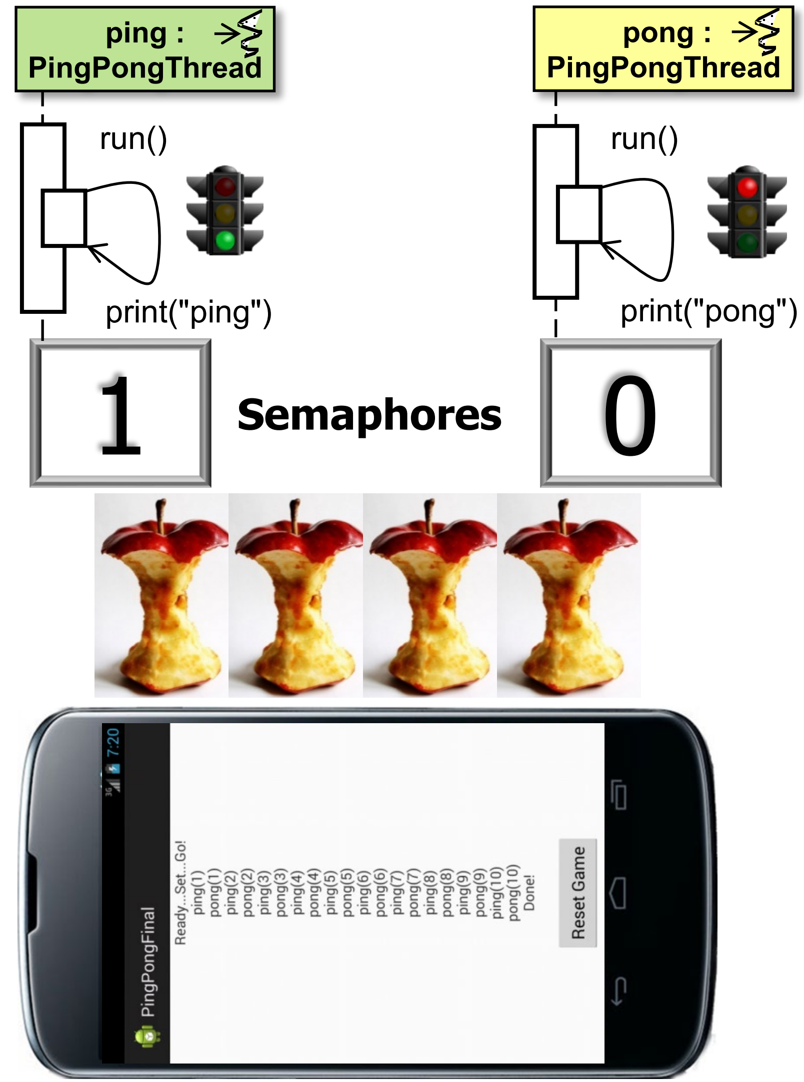
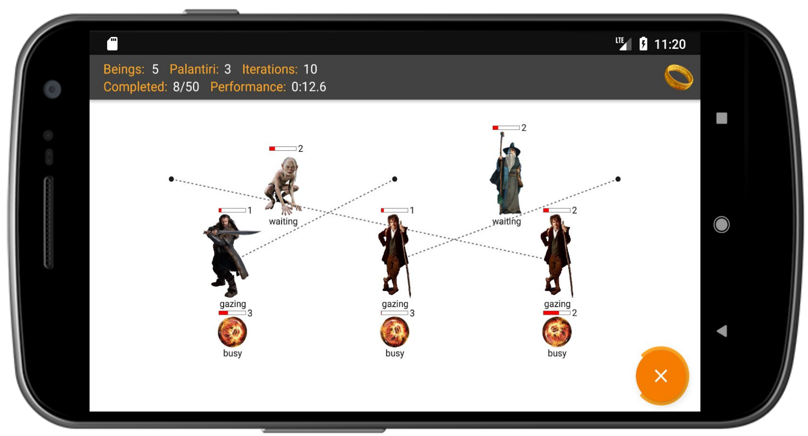


Naturally, this flexibility comes at some additional cost in performance

Java Semaphore Usage Considerations

- When a semaphore is used for a resource pool, it tracks the # of free resources

Semaphore



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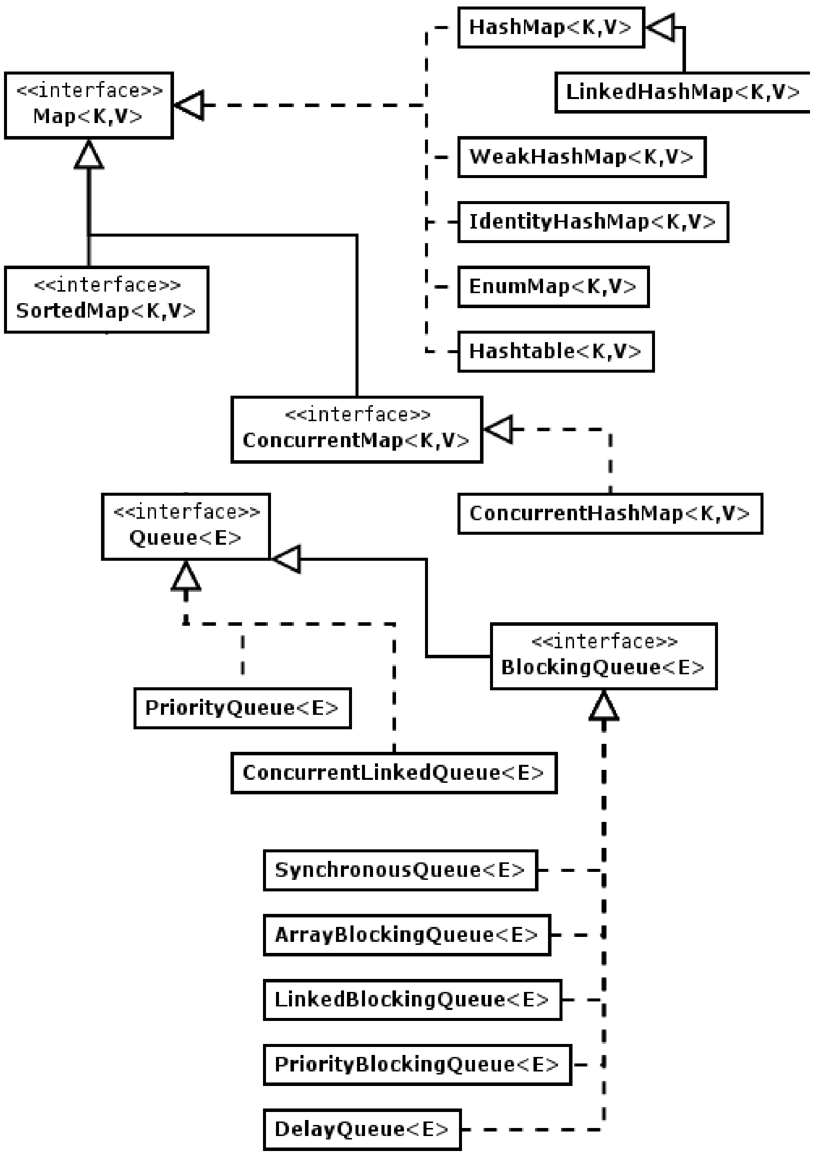
    - e.g., a List, HashMap, etc.



See docs.oracle.com/javase/8/docs/technotes/guides/collections

Java Semaphore Usage Considerations

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  - However, it does not track *which* resources are free
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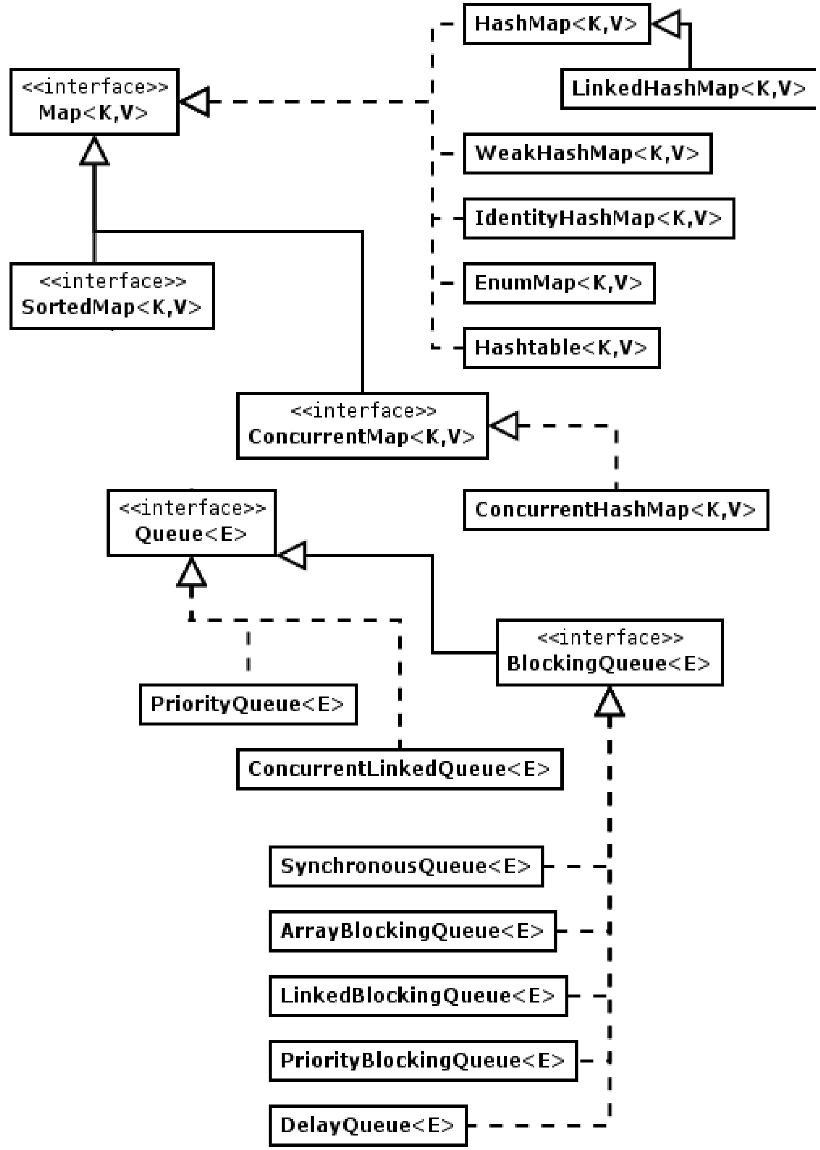

These collections require synchronizers to ensure thread-safety

Java Semaphore Usage Considerations

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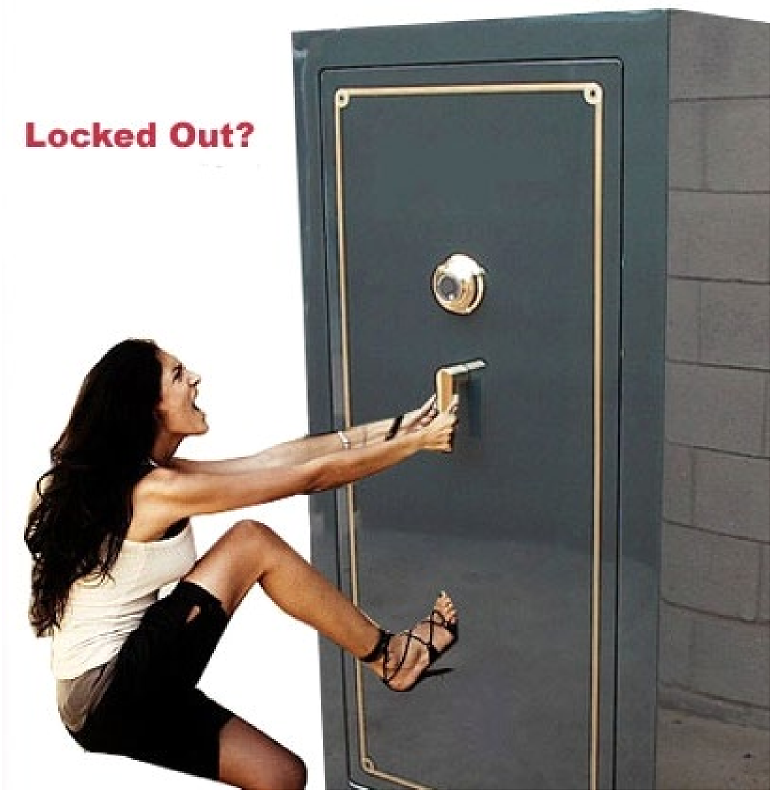


```java
Semaphore semaphore =
  new Semaphore(1);

void someMethod() {
  semaphore.acquire();

  try {
    for (;;) {
      // Do something not
      // involving semaphore
    }
  } finally {
    semaphore.release();
  }
}
```

Other thread(s) won't be able to acquire the semaphore in a timely manner

Java Semaphore Usage Considerations

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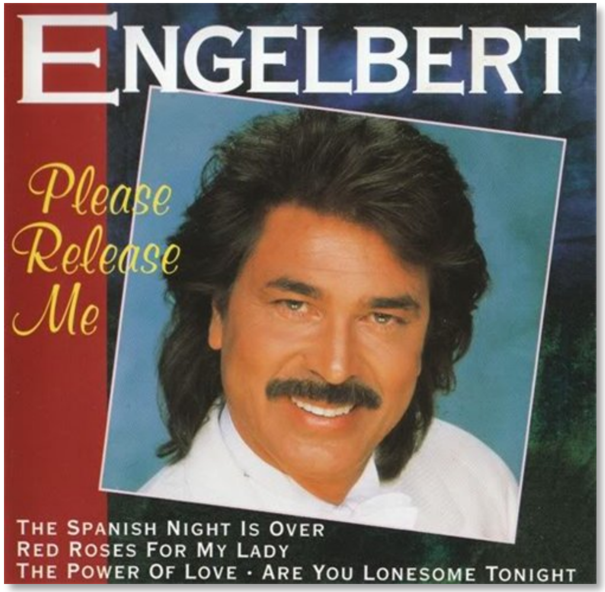
  - Holding a semaphore for a long time without needing it
  - Releasing a semaphore more times than needed




```
Semaphore semaphore =
  new Semaphore(1);

void someMethod() {
  semaphore.acquire();   0
  ...

  semaphore.release();
  semaphore.release();   3
  semaphore.release();
}
```

These extra calls to release() will allow too many threads to acquire the semaphore

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  - Holding a semaphore for a long time without needing it
  - Releasing a semaphore more times than needed
  - Prematurely releasing a semaphore that should have been held

```
Semaphore semaphore =
  new Semaphore(count);

Resource acquireResource() {
  semaphore.acquire();

  // Obtain relevant
  // resource from the pool

  semaphore.release();
  return resource;
}

void releaseResource
       (Resource resource) {
  // Return the resource to
  // the pool.
  semaphore.release();
}
```

This semaphore should have been held for the duration of the returned resource's utilization

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  - Prematurely releasing a semaphore that should have been held
  - Acquiring a semaphore & forgetting to release it

```
Semaphore semaphore =
  new Semaphore(1);

void someMethod() {
  semaphore.acquire();

  ... // Critical section
  return;
}
```

The semaphore may be locked indefinitely!

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```
Semaphore semaphore =
  new Semaphore(1);

void someMethod() {
  semaphore.acquire();
  try {
    ... // Critical section
    return;
  } finally {
    semaphore.release();
  }
}
```

Use the try/finally idiom to ensure a fully-bracketed semaphore is always released, even if exceptions occur

See docs.oracle.com/javase/tutorial/essential/exceptions/finally.html

Java Semaphore Usage Considerations

- Semaphores are rather limited synchronizers that don't scale to complex coordination use cases

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- Semaphores are rather limited synchronizers that don't scale to complex coordination use cases
  - Java ConditionObjects may be a better choice for complex coordination use-cases

Class AbstractQueuedSynchronizer.ConditionObject

java.lang.Object
    java.util.concurrent.locks.AbstractQueuedSynchronizer.ConditionObject

All Implemented Interfaces:

`Serializable, Condition`

Enclosing class:

`AbstractQueuedSynchronizer`

```
public class AbstractQueuedSynchronizer.ConditionObject
extends Object
implements Condition, Serializable
```

Condition implementation for a `AbstractQueuedSynchronizer` serving as the basis of a `Lock` implementation.

Method documentation for this class describes mechanics, not behavioral specifications from the point of view of Lock and Condition users. Exported versions of this class will in general need to be accompanied by documentation describing condition semantics that rely on those of the associated `AbstractQueuedSynchronizer`.

This class is Serializable, but all fields are transient, so deserialized conditions have no waiters.

See upcoming lessons on "*Java ConditionObject*"

End of Java Semaphore Usage Considerations