Overview of How Concurrent Programs are Developed in Java (Part 2)

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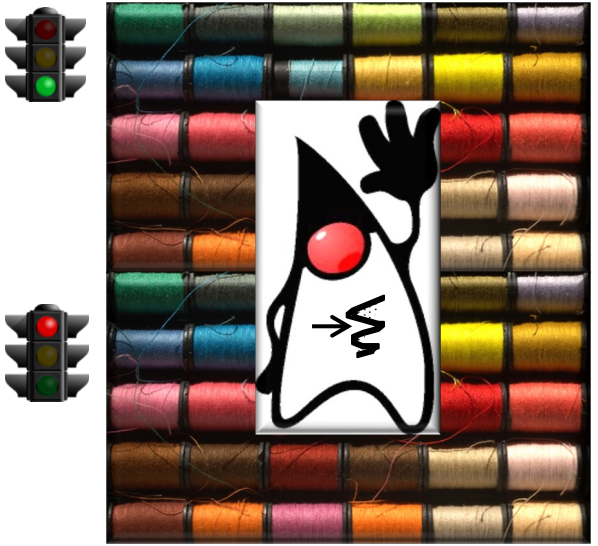
Learning Objectives in this Part of the Lesson

- Understand the meaning of key concurrent programming concepts
- Recognize how Java supports concurrent programming concepts, e.g.
  - Thread objects
  - Interaction mechanisms
    - i.e., shared objects (synchronizers) & message passing



An Overview of Java Thread Interaction Mechanisms

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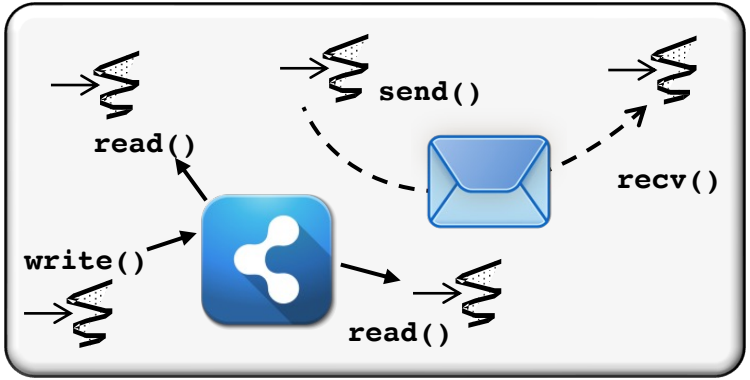
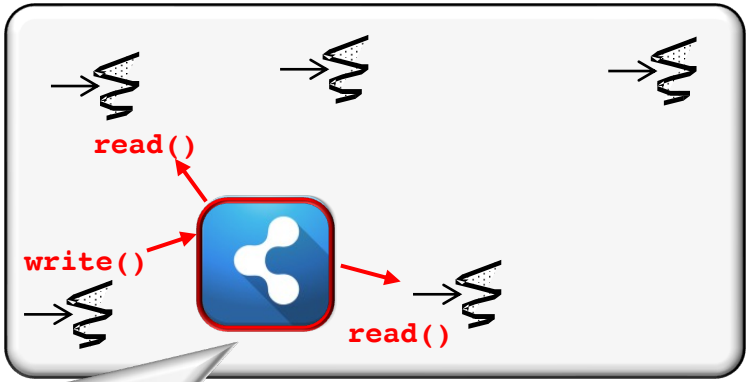
- Java threads interact via shared objects and/or message passing

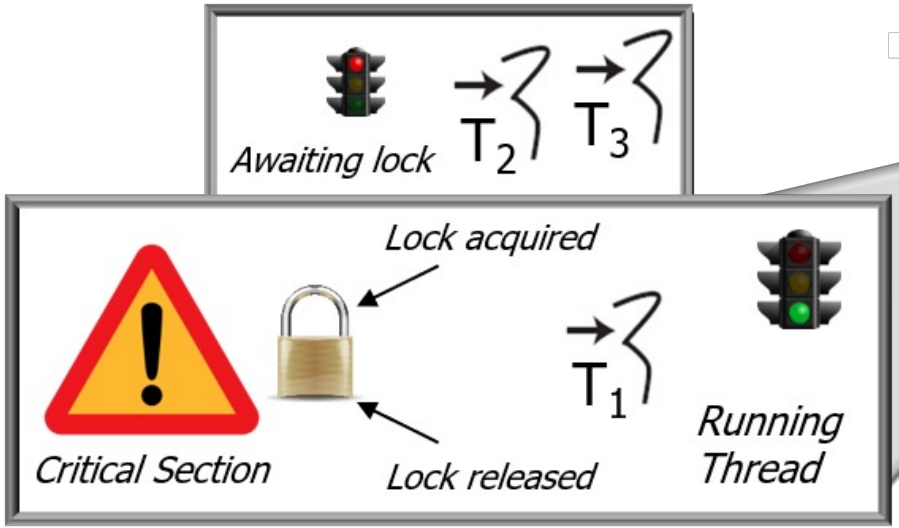


See docs.oracle.com/javase/8/docs/api/?java/util/concurrent/package-summary.html

An Overview of Java Thread Interaction Mechanisms

- Java threads interact via shared objects and/or message passing
  - **Shared objects**
    - Synchronize concurrent operations to ensure certain properties





See en.wikipedia.org/wiki/Synchronization_(computer_science)

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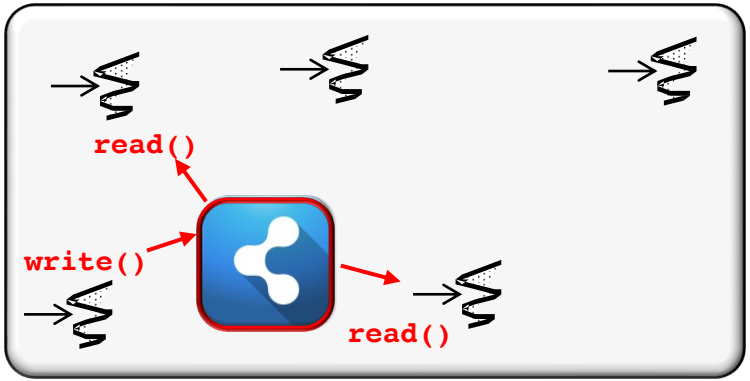
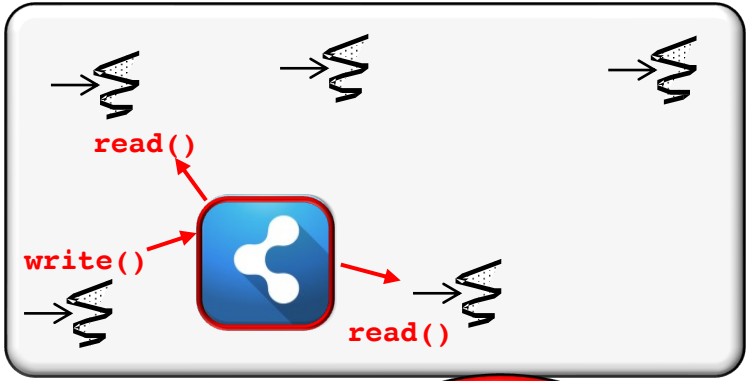
- Java threads interact via shared objects and/or message passing
  - **Shared objects**
    - Synchronize concurrent operations to ensure certain properties, e.g.
      - *Atomicity*
        - Ensures an action either happens completely or doesn't happen at all



See en.wikipedia.org/wiki/Linearizability

An Overview of Java Thread Interaction Mechanisms

- Java threads interact via shared objects and/or message passing
  - **Shared objects**
    - Synchronize concurrent operations to ensure certain properties, e.g.
      - *Atomicity*
      - *Mutual exclusion*
        - Interactions between threads does not corrupt shared mutable data



See en.wikipedia.org/wiki/Monitor_(synchronization)#Mutual_exclusion

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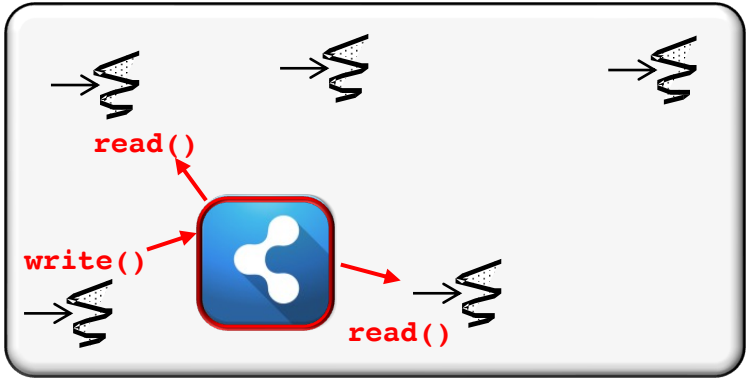
- Java threads interact via shared objects and/or message passing
  - **Shared objects**
    - Synchronize concurrent operations to ensure certain properties, e.g.
      - *Atomicity*
      - *Mutual exclusion*
      - *Coordination*
        - Operations occur in the right order, at the right time, & under the right conditions



See en.wikipedia.org/wiki/Monitor_(synchronization)#Condition_variables

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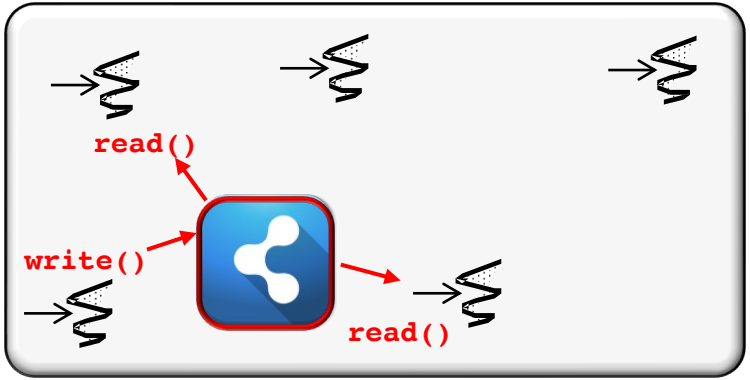
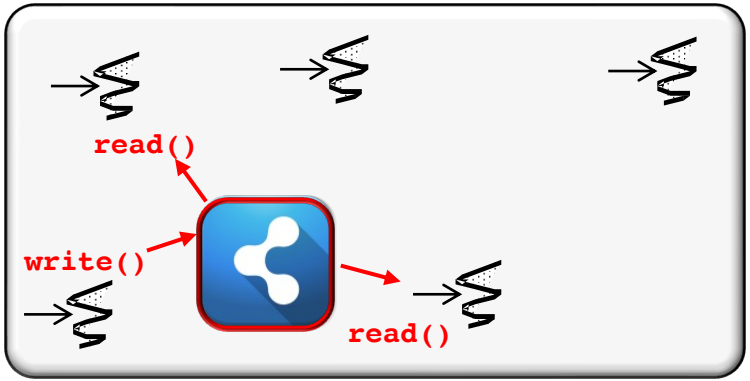
  - **Shared objects**
    - Synchronize concurrent operations to ensure certain properties, e.g.
      - *Atomicity*
      - *Mutual exclusion*
      - *Coordination*
      - *Entry & exit barriers*
        - Enable a group of threads to wait for each other to reach a common execution point before proceeding



See en.wikipedia.org/wiki/Barrier_(computer_science)

An Overview of Java Thread Interaction Mechanisms

- Java threads interact via shared objects and/or message passing
  - **Shared objects**
    - Synchronize concurrent operations to ensure certain properties
    - Examples of Java synchronizers:
      - Atomic operations & volatile
      - Synchronized statements/methods
      - Reentrant & readers-writer locks
      - Semaphores
      - Condition objects
      - Barriers



See dzone.com/articles/the-java-synchronizers

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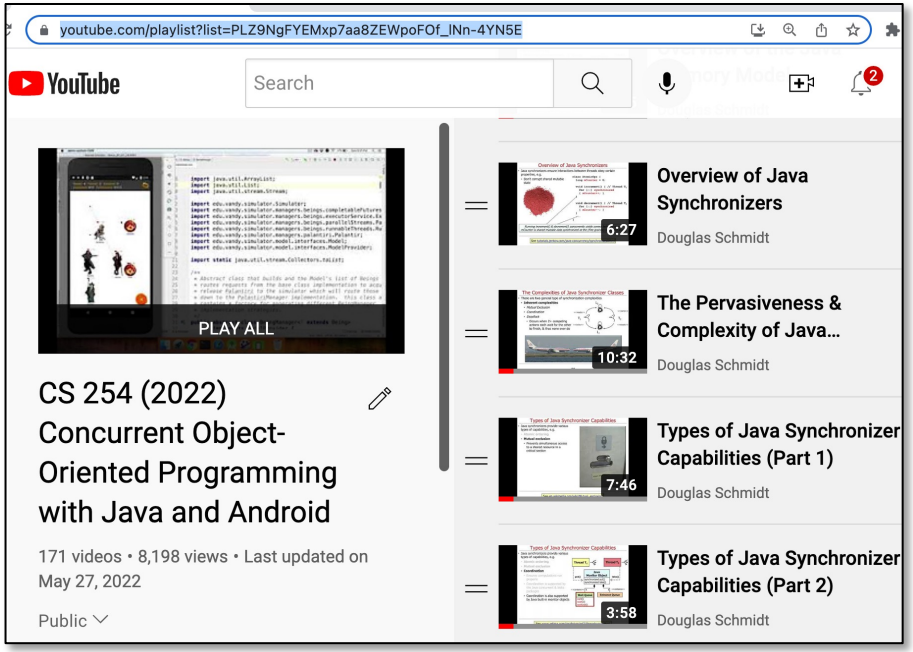
- Java threads interact via shared objects and/or message passing
  - **Shared objects**
    - Synchronize concurrent operations to ensure certain properties
    - Examples of Java synchronizers
    - Java synchronizers are covered in depth at this YouTube playlist



See www.youtube.com/playlist?list=PLZ9NgFYEMxp7aa8ZEWpoFOf_lNn-4YN5E

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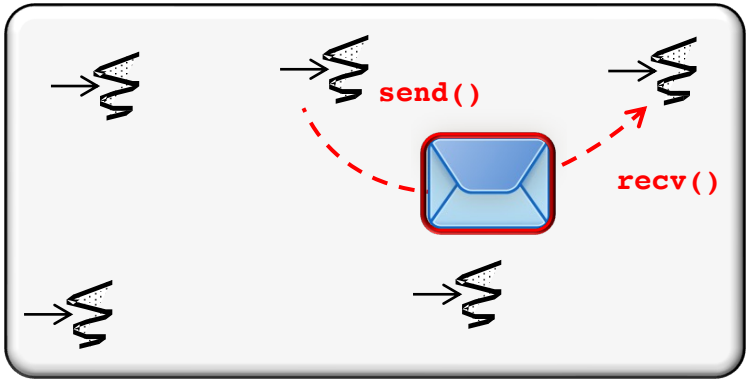
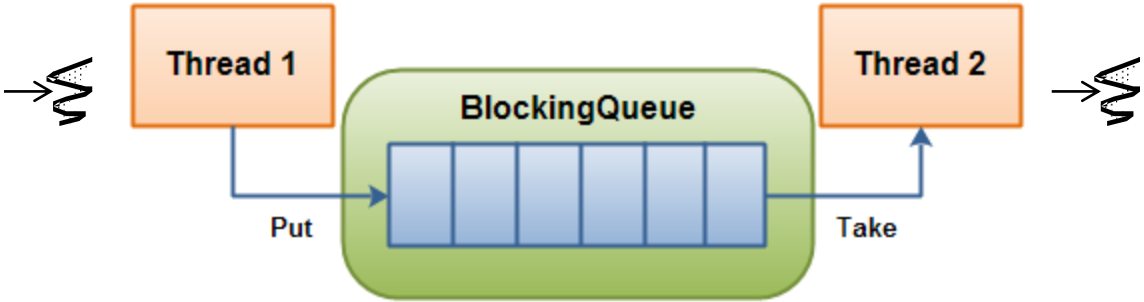
- Java threads interact via shared objects and/or message passing
  - **Shared objects**
    - Synchronize concurrent operations to ensure certain properties
    - Examples of Java synchronizers
    - Java synchronizers are covered in depth at this YouTube playlist
      - Parallel functional programs often need little/no synchronizers due to
        - Immutable data
        - Statelessness
        - Data partitioning

An Overview of Java Thread Interaction Mechanisms

- Java threads interact via shared objects and/or message passing
  - Shared objects
  - **Message passing**
    - Send message(s) from producer thread(s) to consumer thread(s)
      - e.g., via a blocking queue

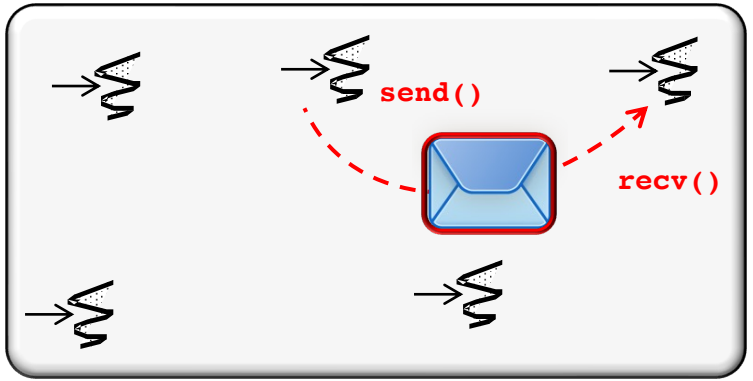


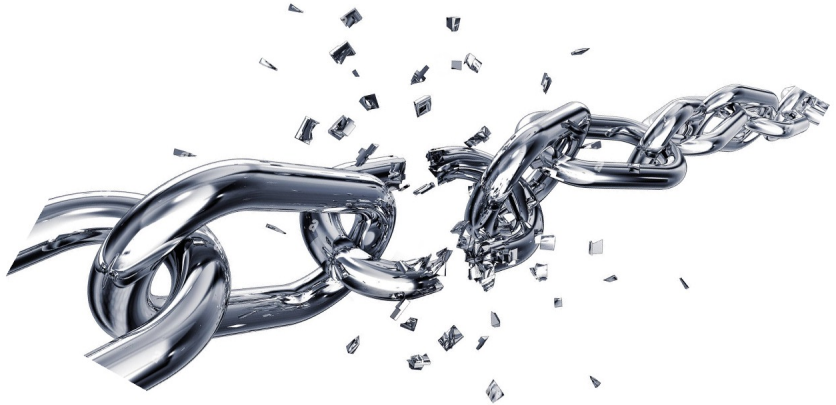


See en.wikipedia.org/wiki/Message_passing

An Overview of Java Thread Interaction Mechanisms

- Java threads interact via shared objects and/or message passing
  - **Shared objects**
  - **Message passing**
    - Send message(s) from producer thread(s) to consumer thread(s)
    - Decouples producer(s) & consumer(s) enhances various quality attributes
      - Scalability
      - Flexibility
      - Load balancing
      - Failure isolation
      - Reuse





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  - **Shared objects**
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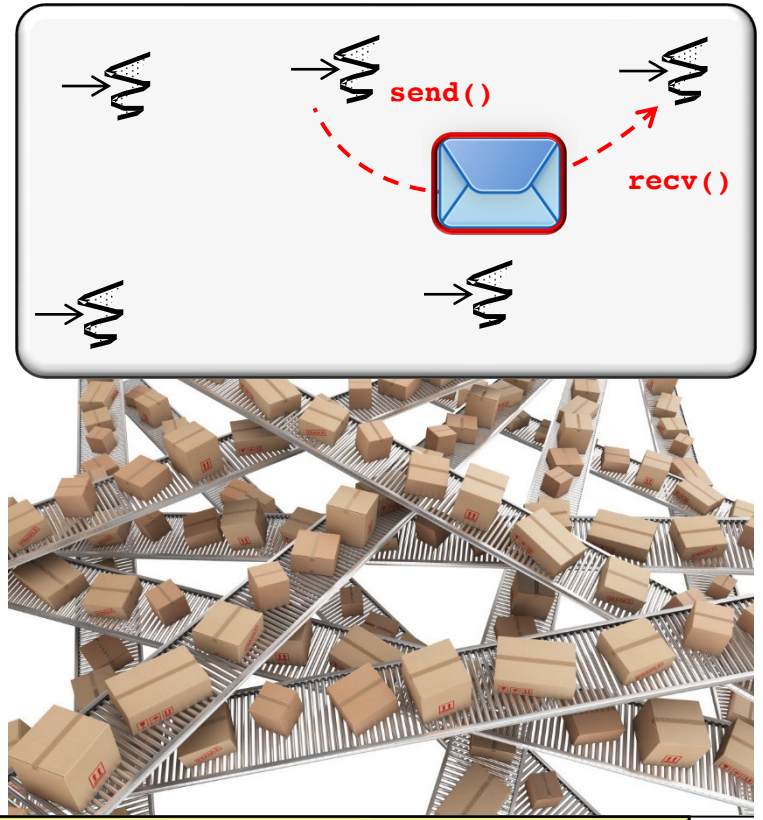
    - Send message(s) from producer thread(s) to consumer thread(s)
    - Decouples producer(s) & consumer(s) enhances various quality attributes
    - Examples of Java thread-safe queues
      - Array & linked blocking queues
      - Priority blocking queue
      - Synchronous queue
      - Concurrent linked queue



See docs.oracle.com/javase/tutorial/collections/implementations/queue.html

End of Overview of How Concurrent Programs are Developed in Java (Part 2)

Discussion Questions

1. Which of the following statements are accurate about Java thread interaction mechanisms as mentioned in the presentation?

   a. *Java threads can only interact via shared objects*

   b. *Mutual exclusion prevents interactions between threads from corrupting shared mutable data*

   c. *Atomic operations & volatile are not examples of Java synchronizers*

   d. *Message passing in Java threads always couples the producer & consumer*

Discussion Questions

2. Which of the following are mentioned as concurrent interaction concepts or mechanisms in Java?

   a. Thread objects

   b. Shared objects (synchronizers)

   c. Message passing

   d. Garbage collection