Introduction to Barrier Synchronization

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Learning Objectives in this Part of the Lesson

• Understand what barrier synchronization is & know three different ways of using barrier synchronizers
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- Understand what barrier synchronization is & know three different ways of using barrier synchronizers
- Note a human known use of barrier synchronization
Overview of Barrier Synchronization
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• Earlier discussions of Java synchronizers have largely focused on classes that affect the behavior of individual threads

See earlier lesson on “Types of Java Synchronizer Capabilities”
Overview of Barrier Synchronization

• Earlier discussions of Java synchronizers have largely focused on classes that affect the behavior of individual threads, e.g.

• Atomic operations are actions that happen effectively all at once or not at all

See earlier lessons on “Java Atomic Operations & Classes”
Overview of Barrier Synchronization

• Earlier discussions of Java synchronizers have largely focused on classes that affect the behavior of individual threads, e.g.
  • Atomic operations are actions that happen effectively all at once or not at all
  • Mutual exclusion synchronizers allow concurrent access & updates to shared mutable data within critical sections

See earlier lessons on "Java ReentrantLock", "Java Semaphore", "Java ReentrantReadWriteLock", "Java StampedLock", & "Java Monitor Objects"
Overview of Barrier Synchronization

- Earlier discussions of Java synchronizers have largely focused on classes that affect the behavior of individual threads, e.g.
  - Atomic operations are actions that happen effectively all at once or not at all
  - Mutual exclusion synchronizers allow concurrent access & updates to shared mutable data within critical sections
  - Coordination synchronizers ensure that computations run properly
    - e.g., in the right order, at the right time, under the right conditions, etc.

See earlier lessons on “Java ConditionObject” & “Java Monitor Objects”
Overview of Barrier Synchronization

In contrast, a barrier is a synchronizer that ensures thread(s) must stop at a certain point & cannot proceed until all other thread(s) reach this barrier.

See en.wikipedia.org/wiki/Barrier_(computer_science)
Overview of Barrier Synchronization

• Barriers can be used in three ways

We’ll use an video rendering engine as a running example in this part of the lesson
Overview of Barrier Synchronization

• Barriers can be used in three ways

A. Entry barrier
  • e.g., keep concurrent computations from running until object(s) are fully initialized
Overview of Barrier Synchronization

- Barriers can be used in three ways

A. **Entry barrier**
- e.g., keep concurrent computations from running until object(s) are fully initialized

*Main thread spawns some # of worker threads & then performs some time-consuming initialization of data structures*
Overview of Barrier Synchronization

• Barriers can be used in three ways

A. Entry barrier

• e.g., keep concurrent computations from running until object(s) are fully initialized

The worker threads wait on the entry barrier until the main thread completes its initializations
Overview of Barrier Synchronization

- Barriers can be used in three ways

**A. Entry barrier**

- e.g., keep concurrent computations from running until object(s) are fully initialized

The main thread decrements the entry barrier to 0, thereby informing worker threads they can continue.
Overview of Barrier Synchronization

- Barriers can be used in three ways
  
  **A. Entry barrier**
  
  **B. Exit barrier**
  
  - e.g., don’t let a thread continue until a group of concurrent threads have finished their processing
Overview of Barrier Synchronization

- Barriers can be used in three ways

A. Entry barrier

B. Exit barrier

- e.g., don’t let a thread continue until a group of concurrent threads have finished their processing

The main thread waits on an exit barrier for all worker threads to finish
Overview of Barrier Synchronization

• Barriers can be used in three ways

A. Entry barrier

B. Exit barrier
  • e.g., don’t let a thread continue until a group of concurrent threads have finished their processing
Overview of Barrier Synchronization

- Barriers can be used in three ways
  - **A. Entry barrier**
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Overview of Barrier Synchronization

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Overview of Barrier Synchronization

• Barriers can be used in three ways

A. Entry barrier

B. Exit barrier
  • e.g., don’t let a thread continue until a group of concurrent threads have finished their processing

When the exit barrier count = 0 the main thread can now continue
Overview of Barrier Synchronization

• Barriers can be used in three ways

A. Entry barrier

B. Exit barrier

C. Cyclic barrier
  • e.g., a group of threads all wait for each other to reach a certain point before advancing to the next cycle
Overview of Barrier Synchronization

- Barriers can be used in three ways
  
  A. Entry barrier
  
  B. Exit barrier
  
  C. Cyclic barrier

- e.g., a group of threads all wait for each other to reach a certain point before advancing to the next cycle

A fixed- or variable-size pool of threads can run concurrently
Overview of Barrier Synchronization

- Barriers can be used in three ways
  A. Entry barrier
  B. Exit barrier
  C. Cyclic barrier
    - e.g., a group of threads all wait for each other to reach a certain point before advancing to the next cycle

At the end of each cycle a decision is made about whether to continue or not
Human Known Uses of Barrier Synchronization
Human Known Uses of Barrier Synchronization

- A human known use is protocol used by a museum tour guide

See en.wikipedia.org/wiki/Tour_guide
A human known use is protocol used by a museum tour guide

A. Entry barrier

• Tourists wait outside museum until it opens or until a tour is schedule to begin
Human Known Uses of Barrier Synchronization

- A human known use is protocol used by a museum tour guide
  
  A. Entry barrier
  
  B. Exit barrier
    - The museum closes only after last group of tourists leave
Human Known Uses of Barrier Synchronization

- A human known use is protocol used by a museum tour guide
  
  A. Entry barrier
  
  B. Exit barrier
  
  C. Cyclic barrier
  
  • Tour guide waits for all the tourists to finish exploring a room before continuing the tour in next room

Cyclic barriers can be used either as entry or exit barriers
Human Known Uses of Barrier Synchronization

- A human known use is protocol used by a museum tour guide
  
  A. Entry barrier  
  B. Exit barrier  
  C. Cyclic barrier

Barriers can be used for both fixed- & variable-sized number of tourists
End of Introduction to Barrier Synchronization