Introduction to Java “Happens-Before” Relationships

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Learning Objectives in this Part of the Lesson

- Understand what “happens-before” relationships mean in Java

Grokking these relationships is essential to mastering concurrent programming
Overview of Java "Happens-Before" Relationships
Overview of Java “Happens-Before” Relationships

• Each action in a single thread “happens-before” every action in that thread that occurs later in the program order

| statement 1; |
| statement 2; |
| statement 3; |
| .           |
| .           |
| statement n; |

All statements happened before n

See earlier lesson on “Java Volatile Variables”
Overview of Java “Happens-Before” Relationships

• In a multi-threaded program, however, actions in different threads can occur in different orders, which can cause problems without proper synchronization.

See en.wikipedia.org/wiki/Thread_safety
Overview of Java “Happens-Before” Relationships

- A “happens-before” relationship is a guarantee by a computing system that if one action “happens before” another action, the results must reflect that ordering

See en.wikipedia.org/wiki/Happened-before
Overview of Java “Happens-Before” Relationships

- A “happens-before” relationship is a guarantee by a computing system that if one action “happens before” another action, the results must reflect that ordering.

There’s a need for programs to properly “signal” the order in which certain actions need to occur.
Overview of Java “Happens-Before” Relationships

• A “happens-before” relationship is a guarantee by a computing system that if one action “happens before” another action, the results must reflect that ordering

• Even if those actions actually execute out of order to optimize program flow & performance

See en.wikipedia.org/wiki/Memory_ordering & en.wikipedia.org/wiki/Out-of-order_execution
Overview of Java “Happens-Before” Relationships

• A “happens-before” relationship in Java is a guarantee by the execution environment that an action performed by one thread is visible to another action in a different thread.

With proper use of synchronization Thread₁ will complete its writes to answer & ready before Thread₂ starts its reads of ready & answer.
Overview of Java “Happens-Before” Relationships

• A “happens-before” relationship in Java is a guarantee by the execution environment that an action performed by one thread is visible to another action in a different thread

• Java atomic operations, variables, & classes enforce “happens-before” relationships on single entities

See earlier lessons on “Atomic Operations, Variables, & Classes”
Overview of Java “Happens-Before” Relationships

- A “happens-before” relationship in Java is a guarantee by the execution environment that an action performed by one thread is visible to another action in a different thread.
- Java atomic operations, variables, & classes enforce “happens-before” relationships on single entities.

See earlier lesson on “Java Volatile Variables”
Overview of Java “Happens-Before” Relationships

• A “happens-before” relationship in Java is a guarantee by the execution environment that an action performed by one thread is visible to another action in a different thread
  
  • Java atomic operations, variables, & classes enforce “happens-before” relationships on single entities
  
  • Our focus here is on “happens-before” relationships involving objects with multiple fields

Note there are multiple fields ‘x’ & ‘y’ involved here
A “happens-before” relationship in Java is a guarantee by the execution environment that an action performed by one thread is visible to another action in a different thread.

- Java atomic operations, variables, & classes enforce “happens-before” relationships on single entities.

- Our focus here is on “happens-before” relationships involving objects with multiple fields.

These relationships often require more elaborate synchronization mechanisms.
End of Introduction to Java “Happens-Before” Relationships