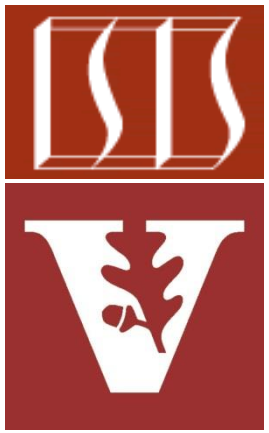
Java "Happens-Before" Relationships: Introduction



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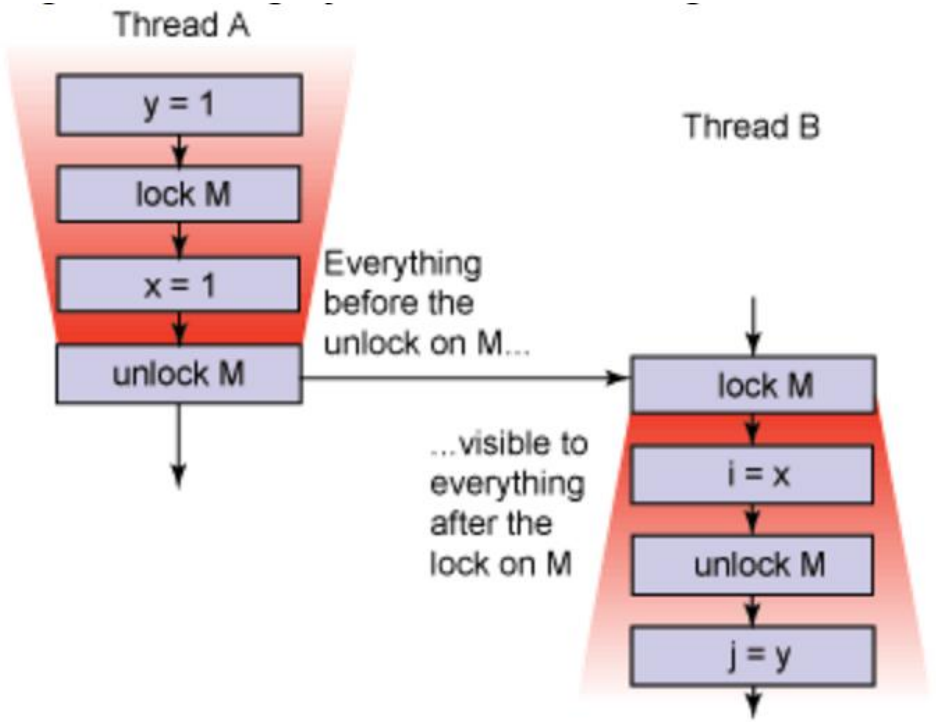
Learning Objectives in this Part of the Lesson

- Understand what "happens-before" relationships mean in Java



Grokking these relationships is essential to mastering concurrent programming

Overview of Java "Happens-Before" Relationships

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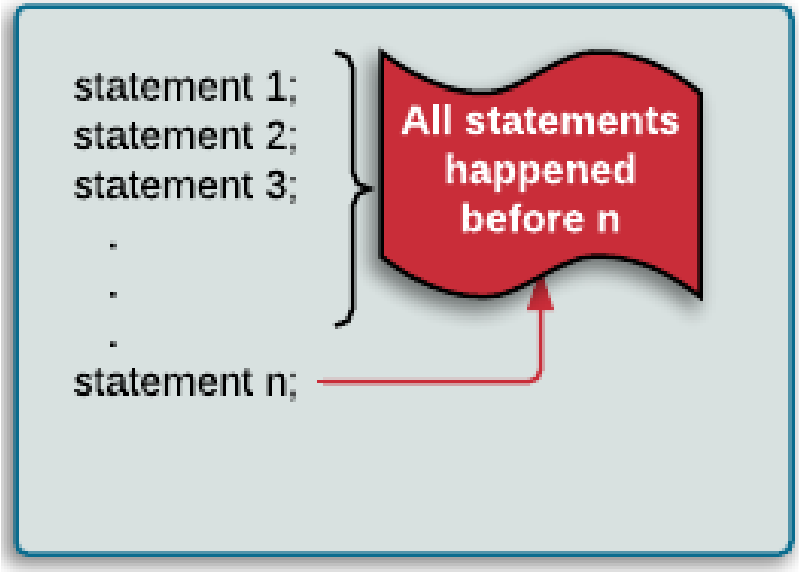
- Each action in a single thread "happens-before" every action in that thread that occurs later in the program order



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

There's a need for programs to properly "signal" the order in which certain actions need to occur

See en.wikipedia.org/wiki/Happened-before

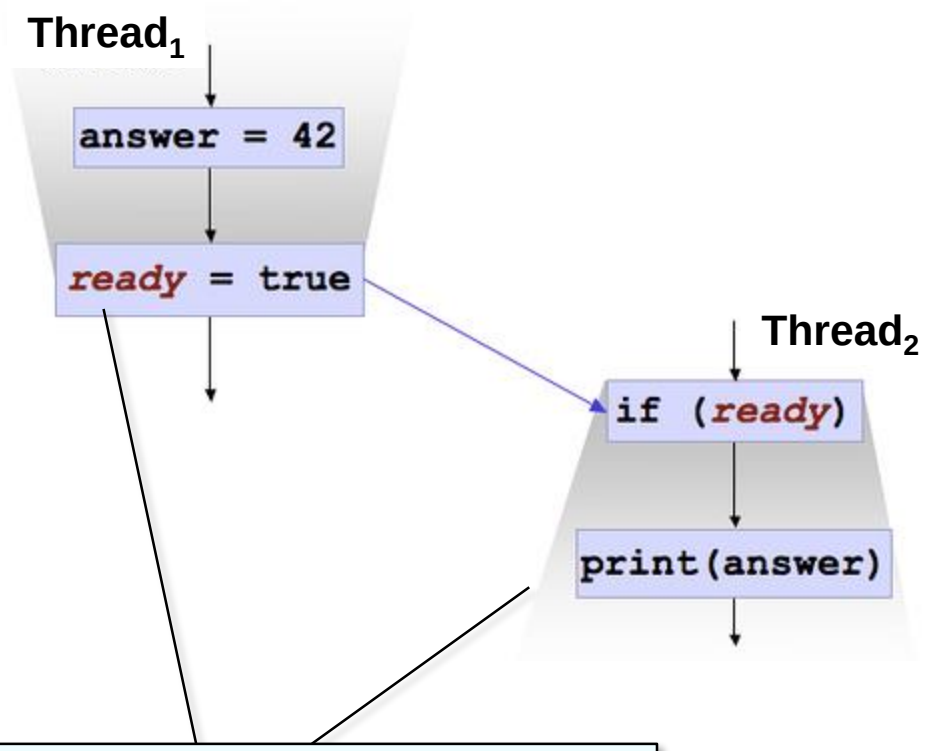
Overview of Java "Happens-Before" Relationships

- 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
  - 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 Thread$_1$ will complete its writes to ***answer*** *&* ***ready*** *before Thread$_2$ starts its reads of* ***ready*** *&* ***answer***

See www.logicbig.com/tutorials/core-java-tutorial/java-multi-threading/happens-before.html

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*"

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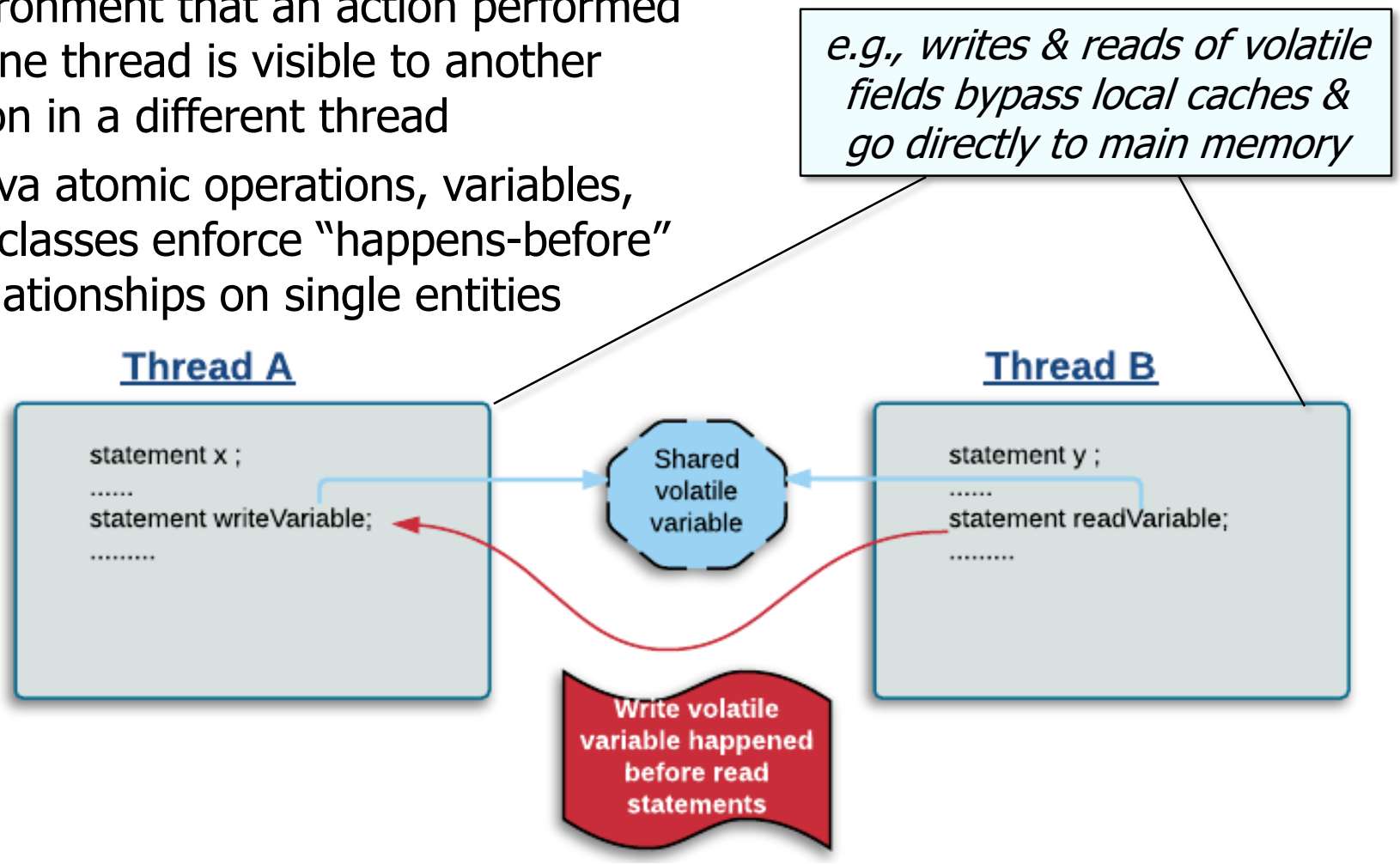

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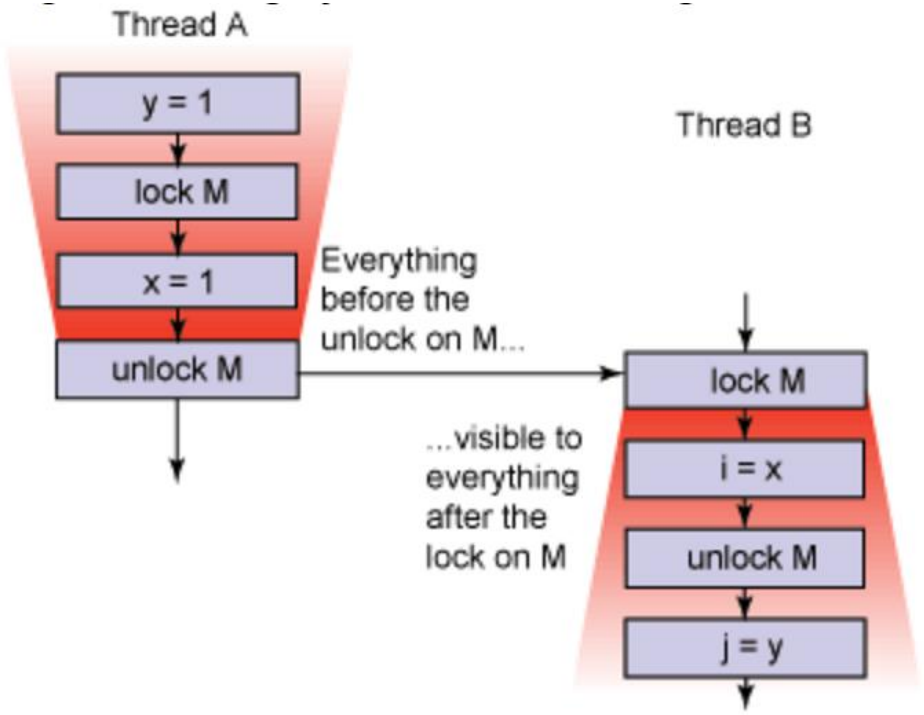

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These relationships often require more elaborate synchronization mechanisms

End of Java "Happens-Before" Relationships: Introduction