Java - Understanding Happens-before relationship

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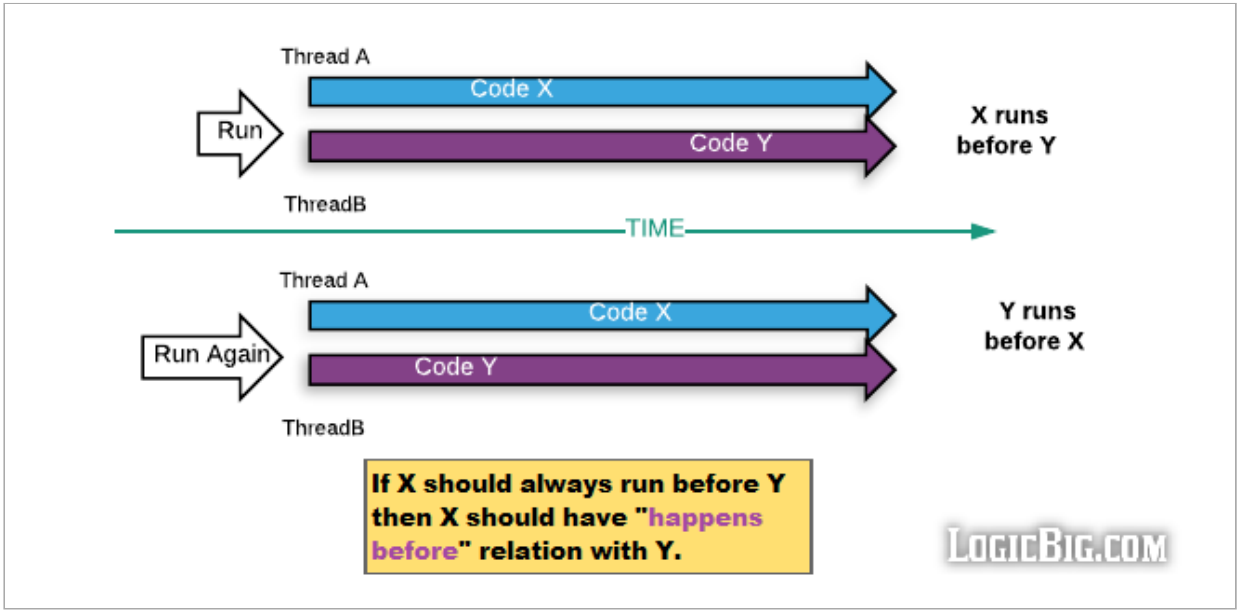

Happens-before relationship is a guarantee that action performed by one thread is visible to another action in different thread.

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Happens-before defines a partial ordering on all actions within the program. To guarantee that the thread executing action Y can see the results of action X (whether or not X and Y occur in different threads), there must be a happens-before relationship between X and Y. In the absence of a happens-before ordering between two operations, the JVM is free to reorder them as it wants (JIT compiler optimization).

Happens-before is not just reordering of actions in 'time' but also a guarantee of ordering of read and write to memory . Two threads performing write and read to memory can be consistent to each other actions in terms of clock time but might not see each others changes consistently (Memory Consistency Errors) unless they have happens-before relationship.

How to establish happens-before relation?

Followings are the rules for happens-before:

- **Single thread rule**: Each action in a single thread happens-before every action in that thread that comes later in the program order.

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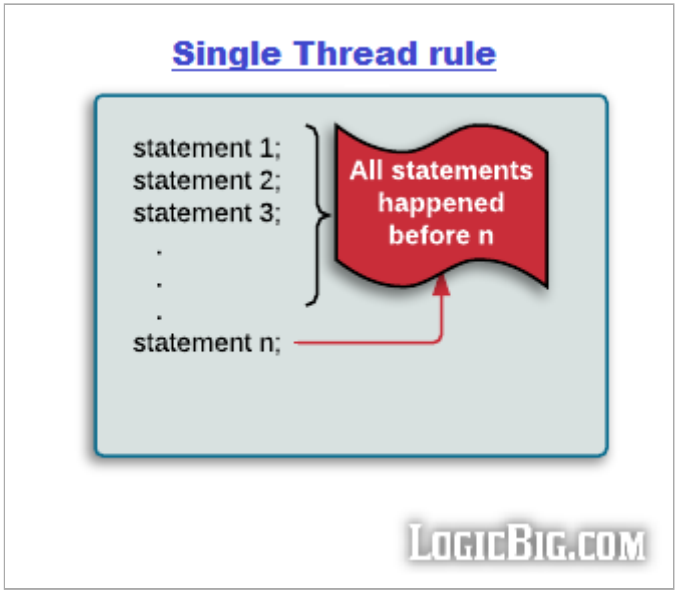
TypeScript - 'this' Parameter in functions



- **Monitor lock rule**: An unlock on a monitor lock (exiting synchronized method/block) happens-before every subsequent acquiring on the same monitor lock.

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TypeScript - Rest Parameters
TypeScript - Optional And Default Parameters in Functions
TypeScript - Function Types
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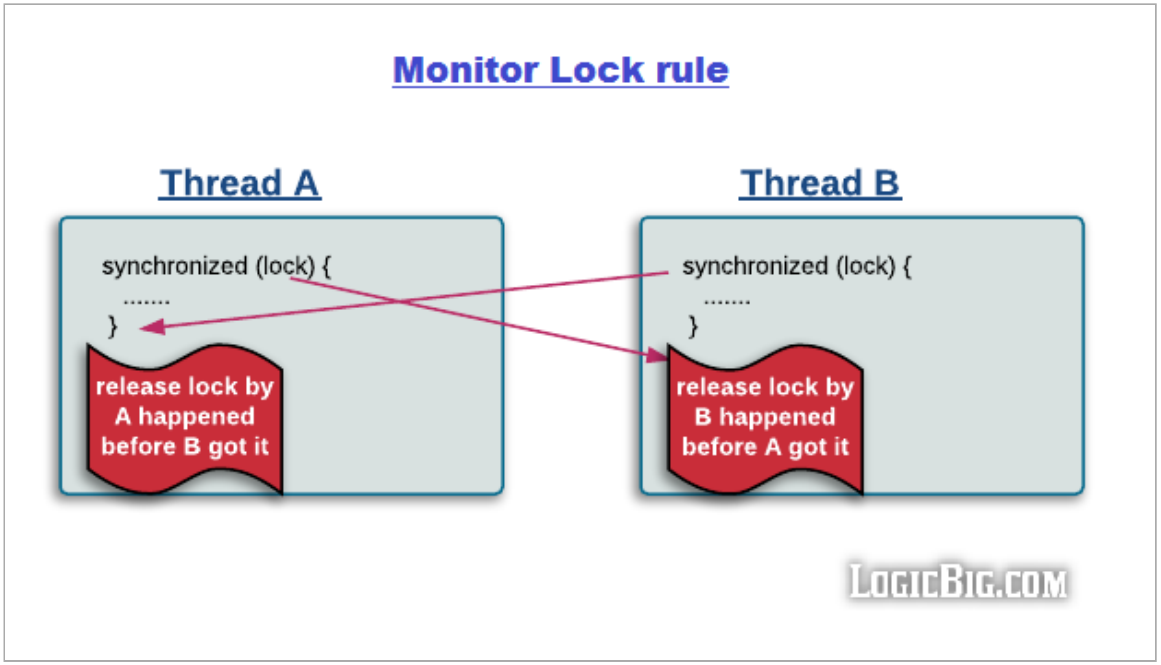
Spring Data JPA - Using @Procedure annotation to call database stored procedure
JPA - Using @NamedStoredProcedureQuery to call database stored procedures
JPA - Calling Database Function
Jackson JSON - Using @JsonManagedReference and @JsonBackReference for circular references
Jackson JSON - Using @JsonIdentityInfo to handle circular references
Jackson JSON - Using @JsonTypeId to override polymorphic type information
Spring Data JPA - Dynamic Projections
TypeScript - Interface Extending Classes
TypeScript - Interface Hybrid Types
TypeScript - Interface Extending Interfaces
TypeScript - Class Implementing Interfaces
JPA - Calling HSQLDB Stored Procedure involving Cursor to get result set
JPA - Calling Stored Procedure With Ref Cursor Output Parameter



- **Volatile variable rule**: A write to a volatile field happens-before every subsequent read of that same field. Writes and reads of volatile fields have similar memory consistency effects as entering and exiting monitors (synchronized block around reads and writes), but without actually aquiring monitors/locks.

Installing Oracle Jdbc Driver to local Maven Repository
Connecting Oracle Database in JPA
JPA - Calling Stored Procedures
Hibernate - Creating Custom ImportSqlCommandExtractor to load scripts containing stored procedures/functions
Spring Cloud - Getting Started Example
Jackson JSON - Using @JsonRootName to customize POJO name to be serialized
Jackson JSON - Using @JsonValue to serialize a single value returned by a method or field
Jackson JSON - Using @JsonRawValue to serialize property as it is
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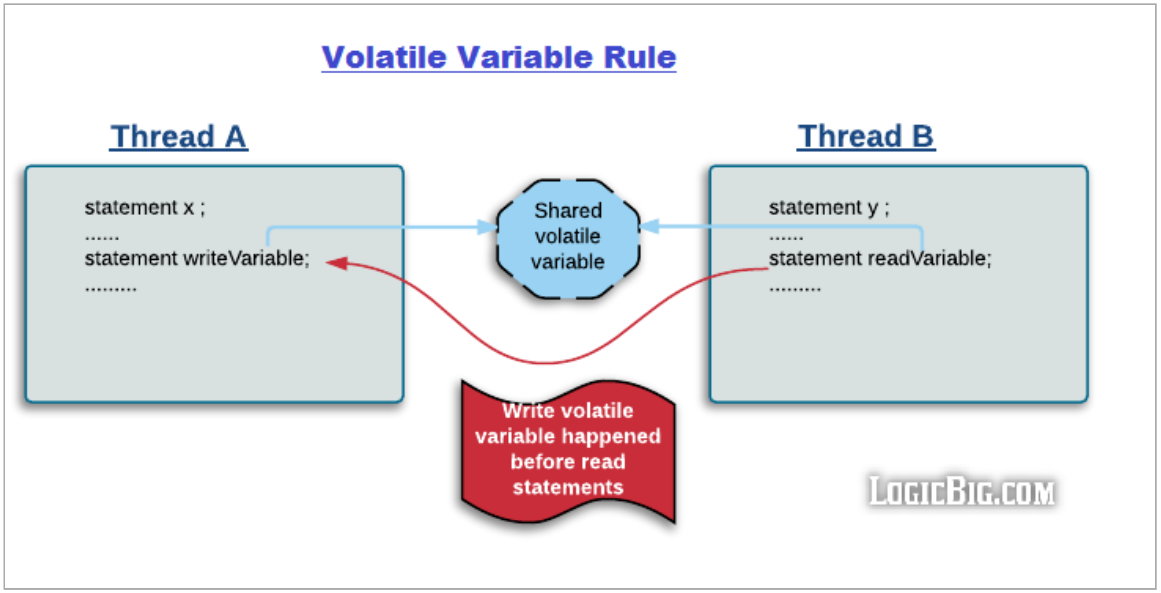
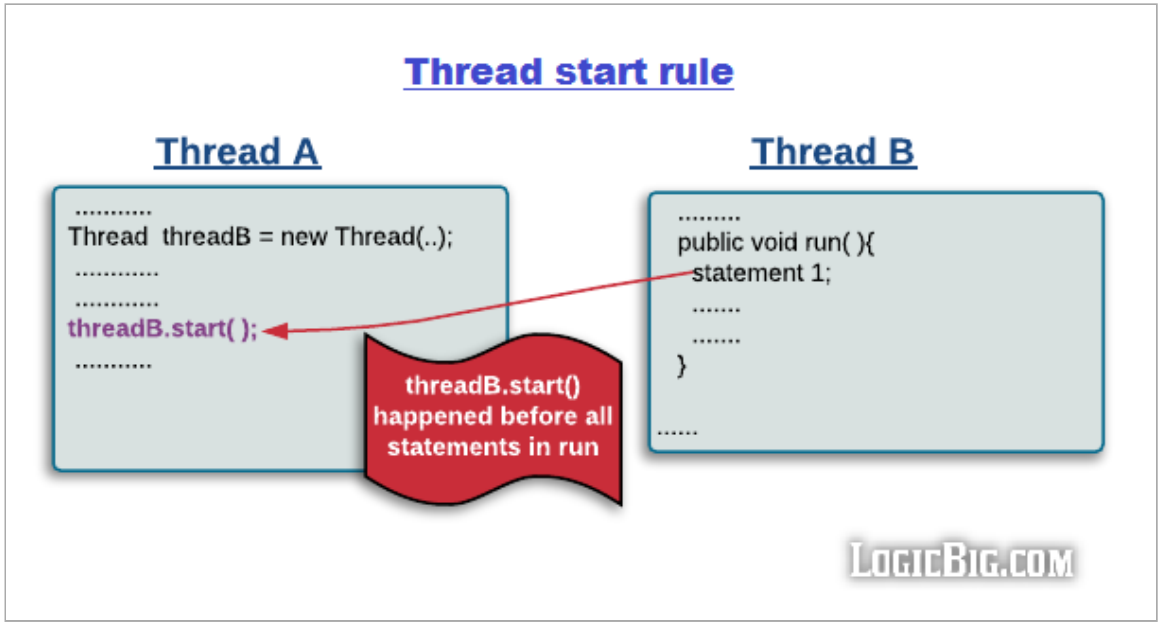
TypeScript - Using Interfaces to describe Functions
TypeScript - Interfaces with Read-Only Properties
TypeScript - Interfaces with Optional Properties
TypeScript - Type Assertions
TypeScript - Using Interfaces to describe Object Properties
TypeScript - Type Inference
Spring Data JPA - Class Based Projections
JPA - Using KEY, VALUE and ENTRY keywords to access Map Entity Relationship in JPQL

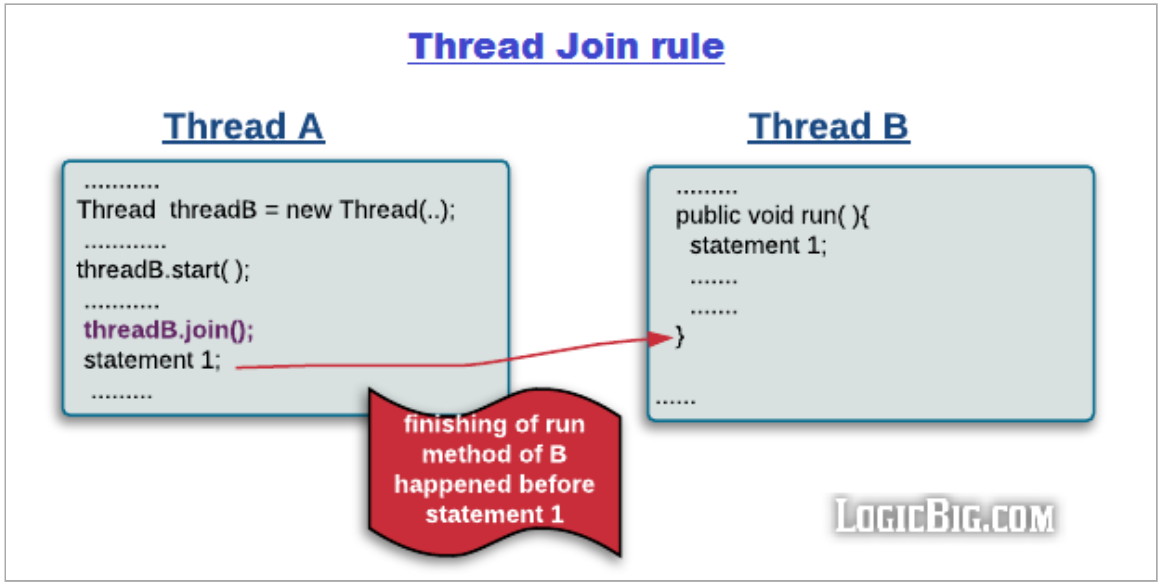


- **Thread start rule**: A call to Thread.start() on a thread happens-before every action in the started thread. Say thread A spawns a new thread B by calling threadA.start(). All actions performed in thread B's run method will see thread A's calling threadA.start() method and before that (only in thread A) happened before them.

JPQL - Using keywords KEY, VLUE, ENTRY to navigate Map element collections
JPA Criteria API - Path Navigation
Fetch Joins in Criteria API
Java Swing - Using OverlayLayout to arrange components over the top of each other
Jackson JSON - Using @JsonPropertyOrder annotation to define serialized properties ordering
Jackson JSON - Using @JsonEnumDefaultValue to mark enum element as default
Jackson JSON - Using @JsonAnySetter to deserialize unmapped JSON properties
Jackson JSON - Using @JsonAnyGetter Annotation to serialize any arbitrary properties
TypeScript - Parameter Properties
TypeScript - Readonly Modifier
TypeScript - Abstract Classes
TypeScript - Access Modifier: public, private and protected access
TypeScript - Inheritance
TypeScript - Class Syntax, Constructor, Member Variables, Methods and Getters/Setters
Spring Data JPA - Invoking Bean Methods from Projections' SpEL expressions



- **Thread join rule**: All actions in a thread happen-before any other thread successfully returns from a join on that thread. Say thread A spawns a new thread B by calling threadA.start() then calls threadA.join(). Thread A will wait at join() call until thread B's run method finishes. After join method returns, all subsequent actions in thread A will see all actions performed in thread B's run method happened before them.



- **Transitivity**: If A happens-before B, and B happens-before C, then A happens-before C.

See Also

A general description of concurrency and multithreading	Synchronized Blocks
Happens-before specs, JLS 17.4.5	Intrinsic Locks and Synchronization
Thread Livelock	Thread interference, Race Condition and Synchronization
Thread Starvation and Fairness	Thread states
Thread Communication using wait/notify	Thread Interrupts
Deadlock	Thread Joining

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