

## **Synchronization Concepts**

Synchronization is a fundamental concept in concurrent programming, ensuring that multiple threads can work together without causing inconsistencies in shared resources. Java provides various synchronization mechanisms to coordinate thread access to shared data. Understanding synchronization is crucial in developing robust and thread-safe applications.

### **Race Conditions**

A race condition occurs when the outcome of a program depends on the sequence or timing of uncontrollable events, such as thread execution order. This can lead to inconsistent or incorrect results. Synchronization prevents race conditions by controlling the access of multiple threads to shared resources.

### **Critical Sections**

A critical section is a block of code that accesses shared resources and must not be executed by more than one thread at a time. Synchronizing critical sections ensures that only one thread can execute the critical section at any given moment.

### **Locks**

Locks are synchronization mechanisms that control access to shared resources. When a thread acquires a lock, other threads trying to acquire the same lock are blocked until the lock is released. Java provides two main types of locks:

### **Deadlocks**

A deadlock occurs when two or more threads are blocked forever, waiting for each other to release resources. Deadlocks can be avoided by using proper synchronization techniques and careful resource allocation.

### **Liveness Issues**

Liveness refers to the ability of a program to continue executing and making progress. Common liveness issues include deadlocks, livelocks (where threads continuously change state but make no progress), and thread starvation (where a thread is perpetually denied access to resources).