

# Threading Problems

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## Overview



**Liveness of an application**

**Common problems with concurrency**

**Different threading problems**

- Deadlock
- Livelock
- Starvation
- Race condition





## Liveness

Liveness is the state of a healthy application. This depends on readiness for requests and responsiveness to requests.





**Availability and stability**

**Responsiveness**

**Memory management**

**Data integrity**



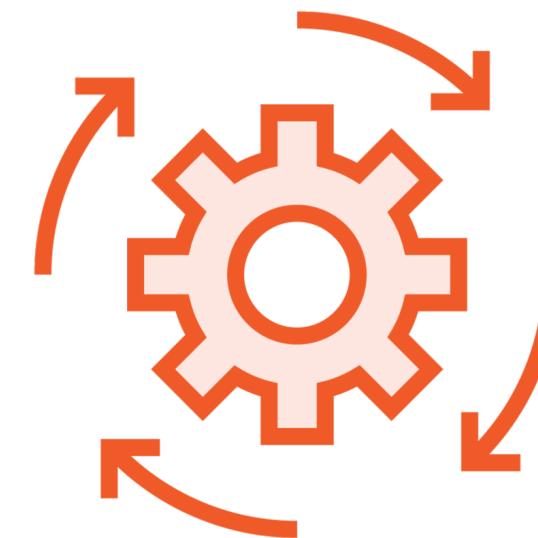
# Threading Problems

**Threading problems are a danger to the liveness, memory consistency and data integrity.**



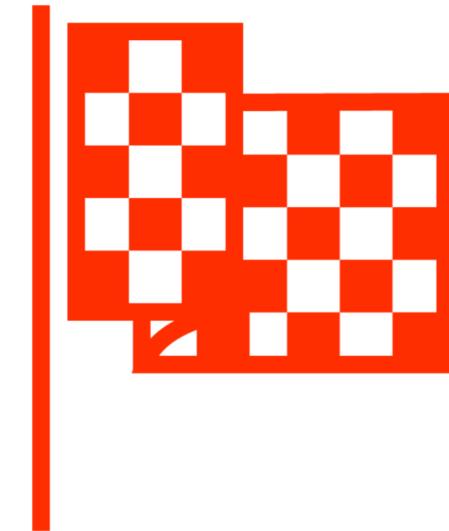
## Deadlock and livelock

**Multiple threads waiting indefinitely on each other or triggering each other in a loop**



## Starvation

**Low priority thread cannot get access to a resource due to high priority threads**



## Race condition

**Multiple threads use the same resource and result depends on order of threads accessing**



# Deadlock



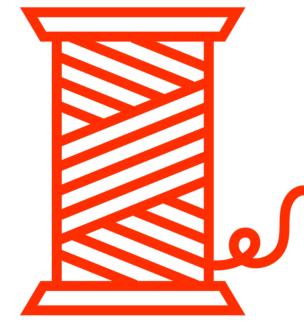
**Waiting state of threads, no progress can be made**

**Threads are holding the resource the other thread(s) need and the other thread(s) holding what the current thread needs**



# Deadlock

Thread 1

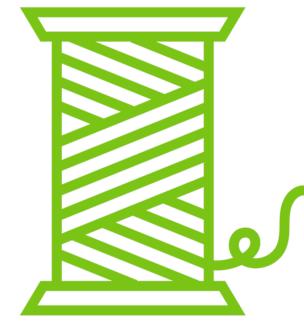


Resource 1



Holding

Needing



Thread 2

Resource 2



Holding

Needing



# Demo



**Run deadlock code**

**Examine deadlock code**

- Why it happens
- How to solve it





## Livelock

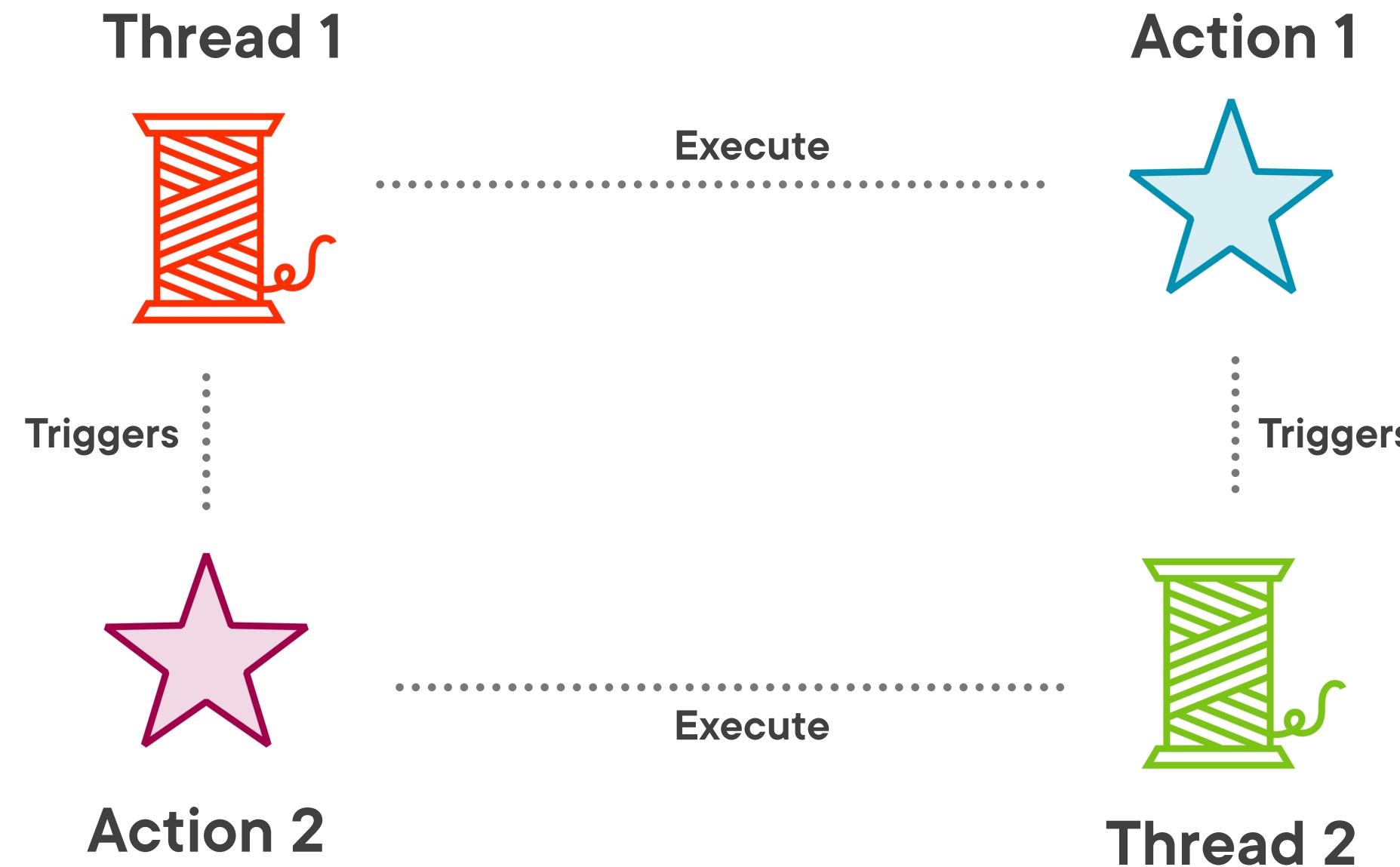
**Threads are triggering each other to do the same action repeatedly**

**Stuck in a loop, but can end by itself in certain situations**

**Terrible for performance and hard to spot**



# Livelock



# Demo



**Run livelock code**

**Examine livelock code**

- Why it happens
- How to solve it





## Starvation

**Normally, all threads get the access to resources they need**

**Starvation: thread with low priority cannot progress due to high priority threads**

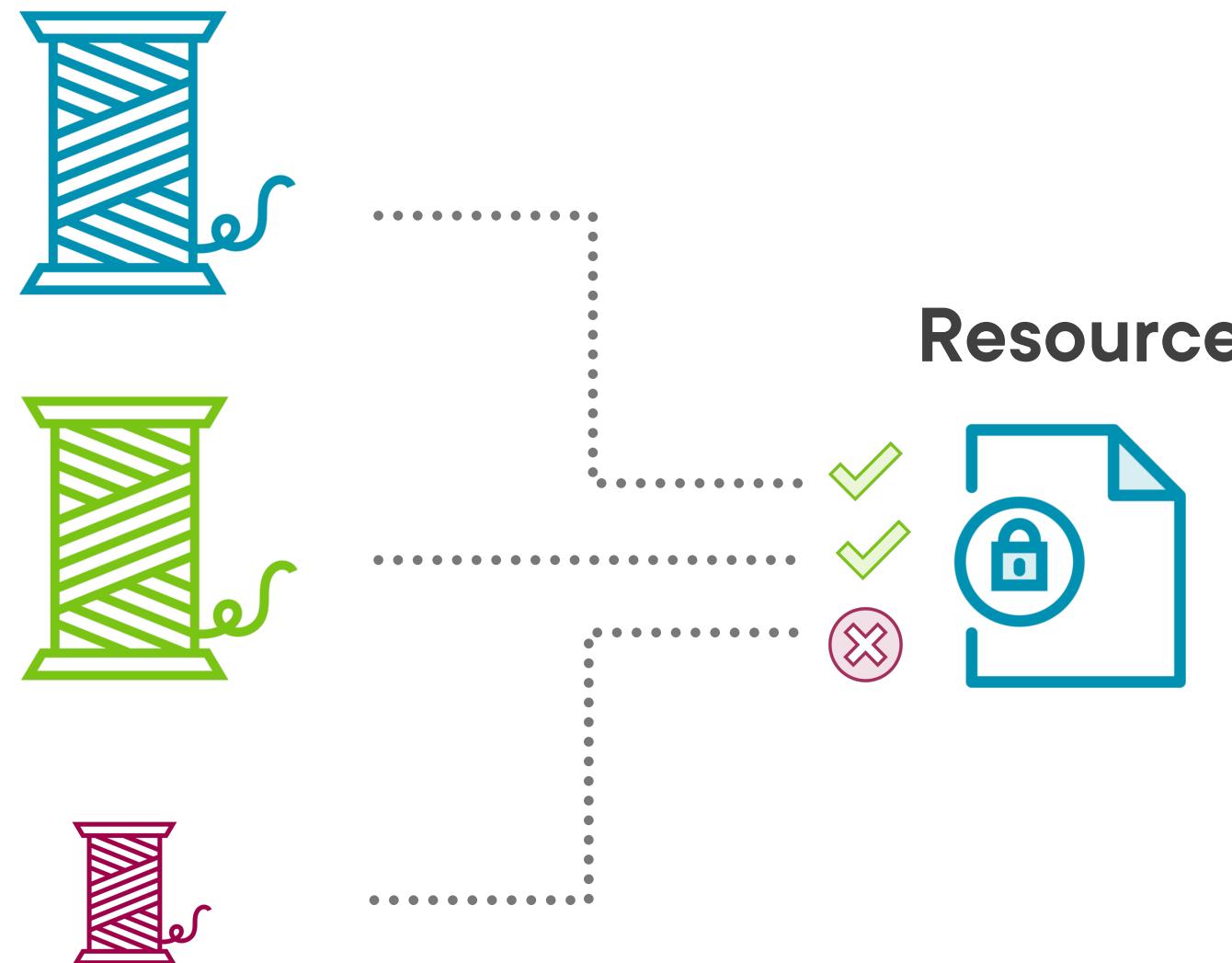
**No access to needed resource due to the resource being high in demand by high priority threads**

**Endangers liveness of the application**



# Starvation

**Multiple  
threads**





## Race Condition

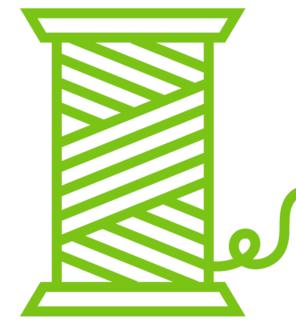
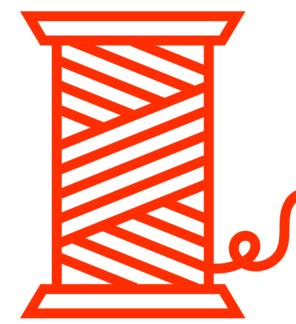
**Multiple threads need access to the same resource**

**Outcome of the operations depends on (coincidental) order of execution**



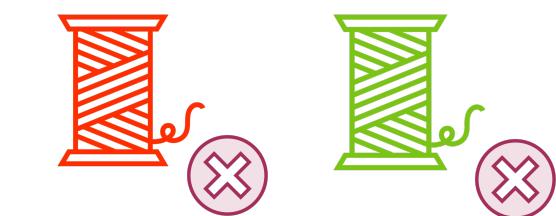
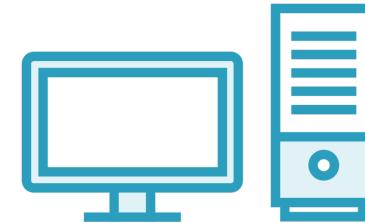
# Race Condition

Two threads



Same request,  
same time

Server



Possible  
outcomes



## Summary



### Threading problems

- Memory inconsistency
- Liveness

### Different types of threading problems

- Deadlock
- Livelock
- Starvation
- Race condition



# Summary



**Concurrency and threads**

**Synchronized and locks**

**ExecutorService and thread pools**

**Concurrent Collections**

**Atomic classes**

**Threading problems**

