

Advanced Memory Leaks



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Class Loader Memory Leaks



Class Loader

A Class Loader is a mechanism for dynamically loading Java classes, as raw bytecode, into a JVM.



Why Are Class Loaders Used?

All Classes are loaded by an class loader

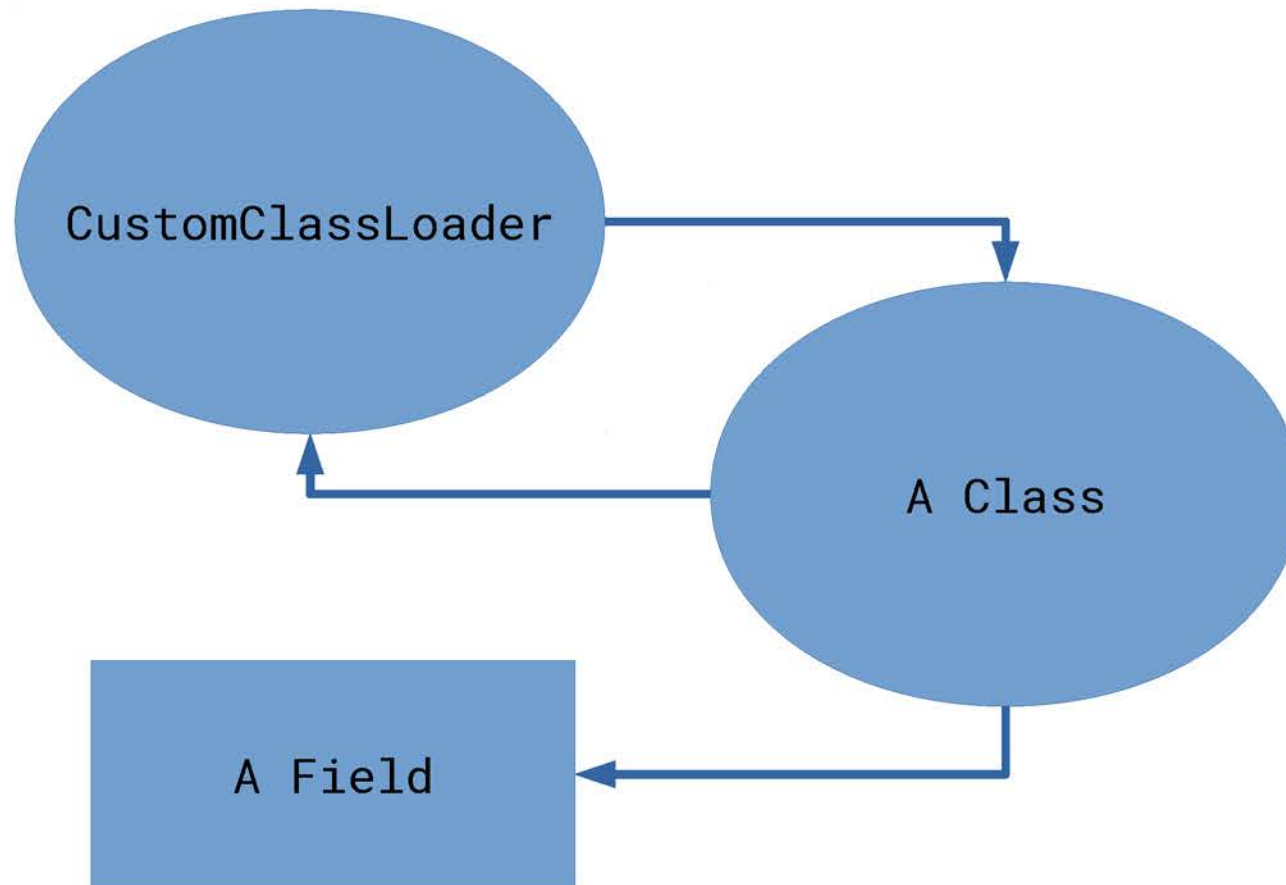
The JVM has 3 built-in class loaders – bootstrap, extension and system

User defined class loaders are commonly used as an extension mechanism

For example in loading plugins or servlet containers



Why Are Class Loader Leaks a Problem?



Demo



Live code a tiny application runner that repeatedly loads plugins

The plugin loader leaks memory

We will then diagnose the problem



ThreadLocal Memory Leaks



ThreadLocal

A field, where each thread has its own independently initialized copy of the variable.




```
ThreadLocal<Foo> value  
= ThreadLocal.withInitial(()  
-> new Foo());
```

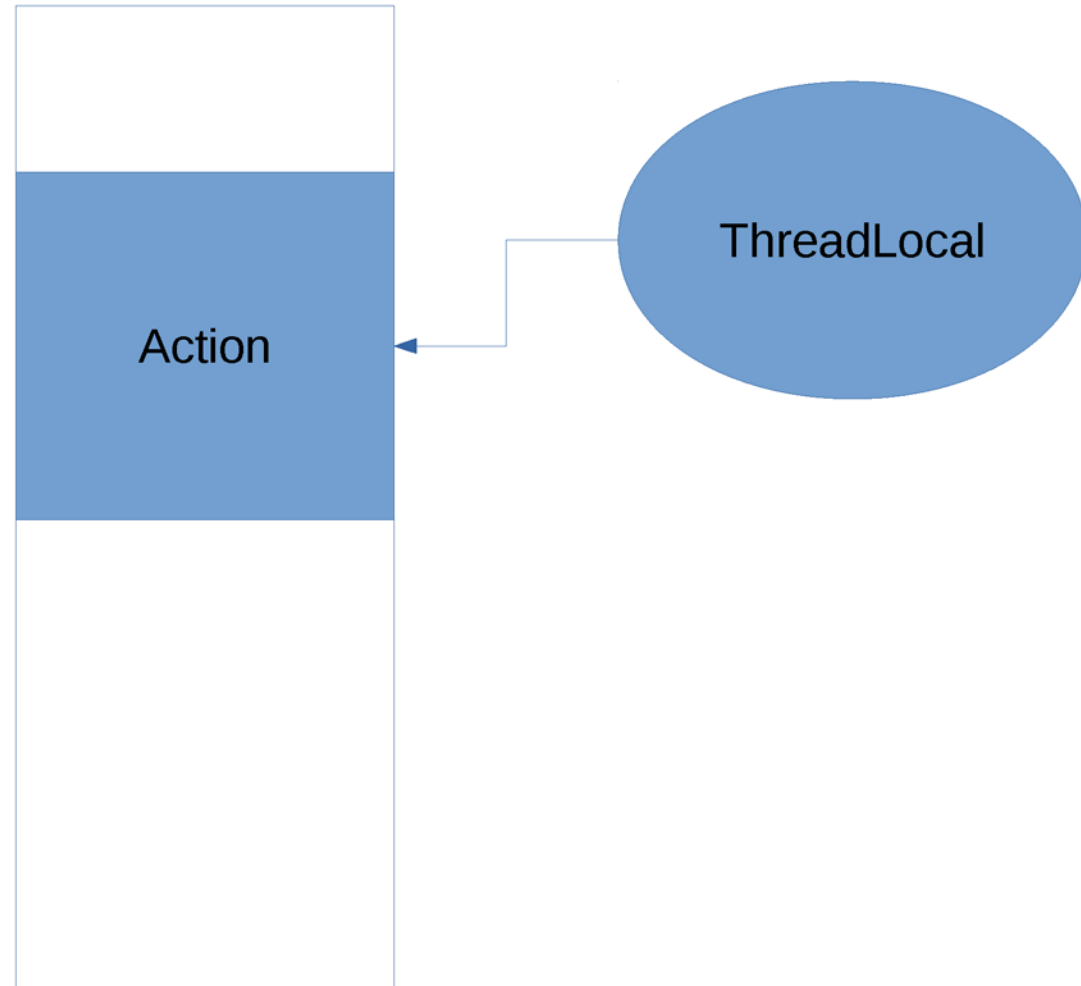
```
Foo foo = value.get();
```

```
value.remove();
```

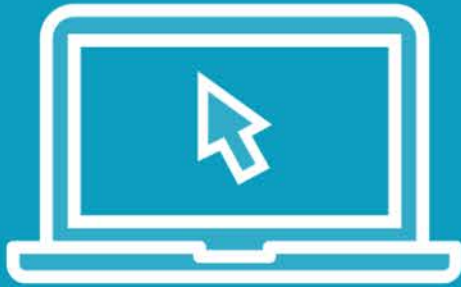
- ◀ **Generic Wrapper class.**
- ◀ **Provide a function to initialize the value.**
- ◀ **Call get() to retrieve a value.**
- ◀ **remove() clears state.**



The ThreadLocal problem



Demo



Run some actions on a small thread pool

The actions use thread locals

When they complete the thread pool stays live, keeping the thread locals referenced



Off Heap Memory Leaks



Memory Regions

Heap Memory

Managed by the JVM/GC

Arena allocated regions

Java Objects allocated here

Off-Heap Memory

Managed Manually

Individually allocated buffers

Custom data stores



Types of Off Heap Memory



Native Code

JNI Invoked native libraries. Out of scope.



DirectBuffers

Off heap buffers allocated by Java code



Memory Mapped Files

Used for interprocess communications.



Off Heap storage won't
appear as retained heap.



```
top -p<pid>
```

```
-XX:MaxDirectMemorySize=1g
```

- ◀ Can use top to identify memory really used
- ◀ Isolate to a process
- ◀ Enforce buffer allocation limit
- ◀ Stops unbounded growth
- ◀ Still need to find leaks



Demo



Direct Buffer Leak

Tool Inspection

- Top
- Mbeans

Existing tracing mechanisms for reachability



Summary



Summary



Covered Three types of memory leak

- ClassLoaders
- ThreadLocals
- OffHeap Memory

These advanced memory leaks can happen quite often

