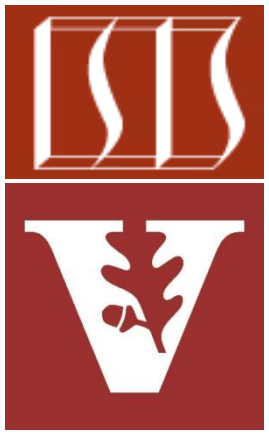
Java Atomic Classes & Operations: Applying Java AtomicLong



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Learning Objectives in this Part of the Lesson

- Understand how Java atomic classes & operations provide concurrent programs with lock-free, thread-safe mechanisms to read from & write to single variables
- Note a human known use of atomic operations
- Know how Java atomic operations are implemented
- Recognize how the Java AtomicLong & AtomicBoolean classes are implemented
- Be aware of how to apply Java AtomicLong in practice

```
class Random ... {
  public Random() {
    this(seedUniquifier()
         ^ System.nanoTime());
  }

  private static long seedUniquifier(){
    for (;;) {
      long s = seedUniquifier.get();
      long next =
        s * 1181783497276652981L;
      if (seedUniquifier
            .compareAndSet(s, next))
        return next;
    }
}

private static final AtomicLong
  seedUniquifier = new
    AtomicLong(8682522807148012L);
```

Applying Java AtomicLong

Implementing Java AtomicLong

- The Java Random class uses an AtomicLong to generate seeds that are reasonable unique

```
class Random ... {
  public Random() {
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See share/classes/java/util/Random.java

Implementing Java AtomicLong

- The Java Random class uses an AtomicLong to generate seeds that are reasonable unique

The default constructor creates a random seed based on a computed value xor'd with the current time

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An AtomicLong that is initialized to a large value

Implementing Java AtomicLong

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Factory method that atomically generates the next "unique" seed value

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class Random ... {
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        s * 1181783497276652981L;
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```

This code runs in a loop for reasons we'll discuss shortly!

Implementing Java AtomicLong

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    }
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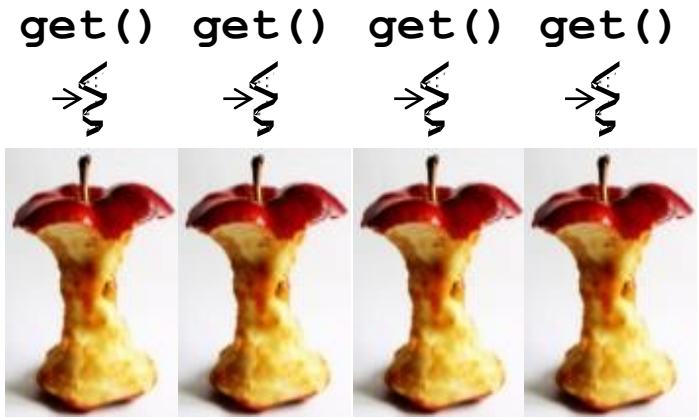
```

Atomically read the current seed value



Multiple threads running on multiple cores can call get() concurrently

Implementing Java AtomicLong

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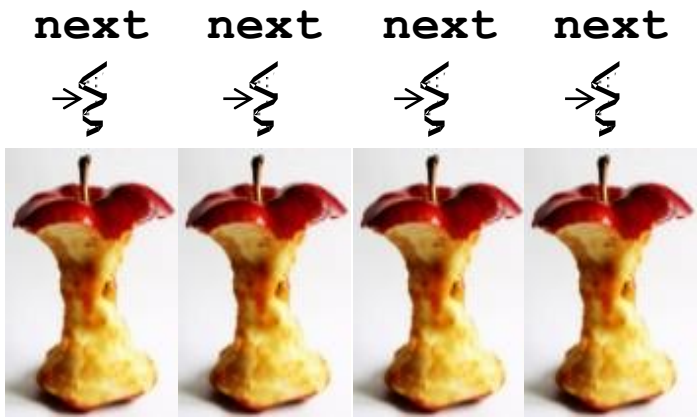
Compute a potential next seed value



This computation of **next** is deterministic

Implementing Java AtomicLong

- The Java Random class uses an AtomicLong to generate seeds that are reasonable unique

```
class Random ... {
  public Random() {
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  for (;;) {
    long s = seedUniquifier.get();
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    if (seedUniquifier
          .compareAndSet(s, next))
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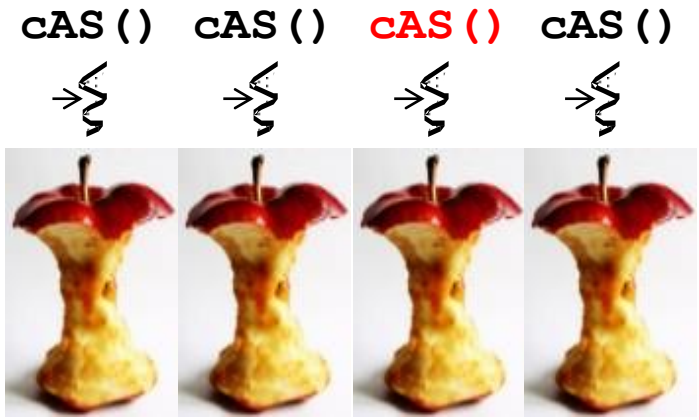
```

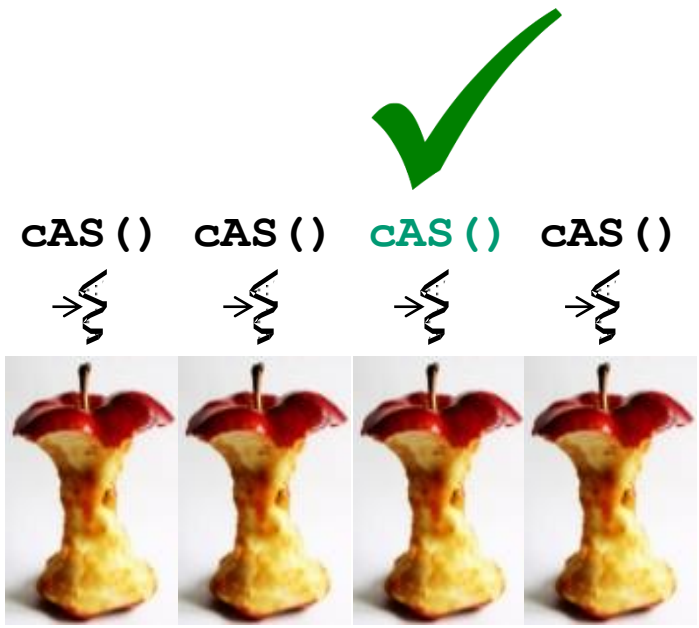
Try to set the computed next seed atomically, which succeeds only if `s` *is still the current seed value*



compareAndSet() is only called once per loop, per thread & only succeeds in one thread

Implementing Java AtomicLong

- The Java Random class uses an AtomicLong to generate seeds that are reasonable unique



Return the next seed value if compareAndSet() succeeded

```
class Random ... {
  public Random() {
    this(seedUniquifier()
         ^ System.nanoTime());
  }

  private static long seedUniquifier(){
    for (;;) {
      long s = seedUniquifier.get();
      long next =
        s * 1181783497276652981L;
      if (seedUniquifier
            .compareAndSet(s, next))
        return next;
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            .compareAndSet(s, next))
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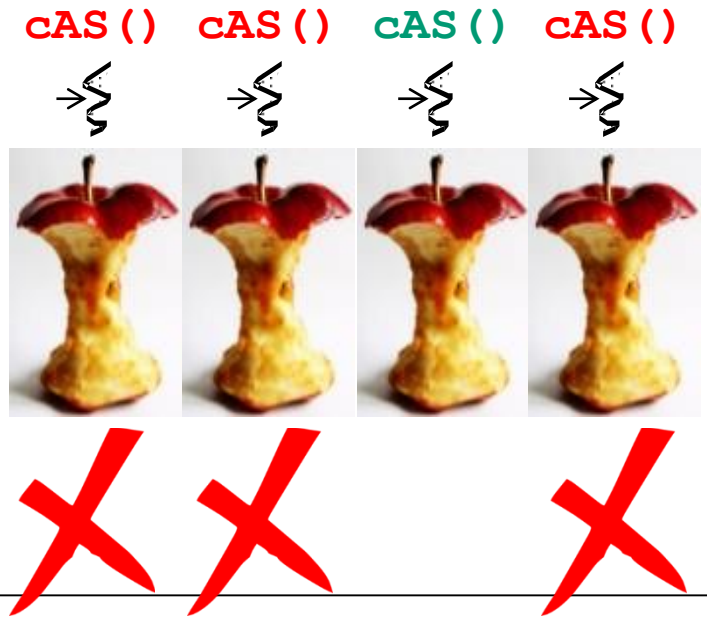
```

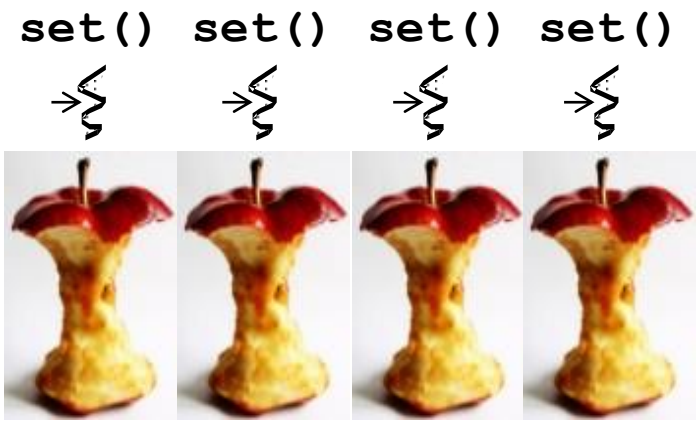
Otherwise, loop again & keep trying until success



Implementing Java AtomicLong

- The Java Random class uses an AtomicLong to generate seeds that are reasonable unique
  - compareAndSet() is used to ensure unique seeds in the face of multiple cores

If this code is run concurrently by multiple threads on multiple cores the resulting seeds may be identical!




```
class Random ... {
  public Random() {
    this(seedUniquifier()
         ^ System.nanoTime());
  }

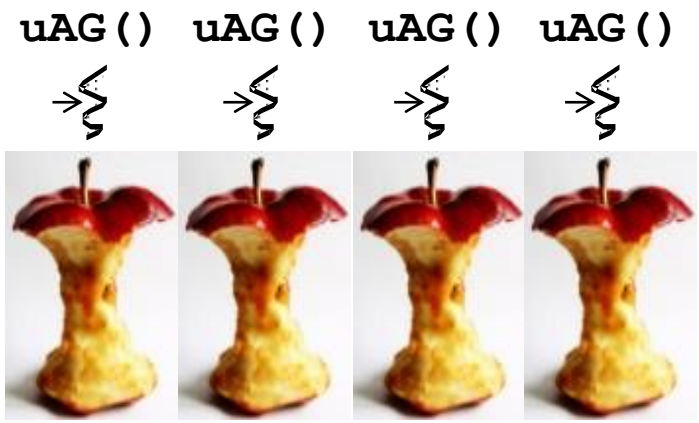
  private static long seedUniquifier(){
    seedUniquifier
      .set(seedUniquifier.get()
           * 1181783497276652981L);
    return seedUniquifier.get();
  }

  private static final AtomicLong
    seedUniquifier = new
      AtomicLong(8682522807148012L);
  ...
```

Implementing Java AtomicLong

- The Java Random class uses an AtomicLong to generate seeds that are reasonable unique
  - compareAndSet() is used to ensure unique seeds in the face of multiple cores

Even this clever Java 8+ version suffers from the same problems




```
class Random ... {
  public Random() {
    this(seedUniquifier()
         ^ System.nanoTime());
  }

  private static long seedUniquifier(){
    return seedUniquifier
      .updateAndGet(cur -> cur
           * 1181783497276652981L);
  }

  private static final AtomicLong
    seedUniquifier = new
      AtomicLong(8682522807148012L);
  ...
```

End of Atomic Classes & Operations: Applying Java AtomicLong