Overview of the Java Memory Model

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Learning Objectives in this Part of the Lesson

• Be aware of the Java memory model
Overview of the Java Memory Model
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- Java’s memory model defines semantics of multi-threaded access to shared memory

See gee.cs.oswego.edu/dl/cpj/jmm.html
Overview of the Java Memory Model

- Java’s memory model defines semantics of multi-threaded access to shared memory, e.g.,
  - Which instruction reorderings are allowed in memory

There are various potential sources of reordering, e.g., the Java compiler, the Just-In-Time (JIT) compiler, processor instruction pipelines, caches, etc.
Overview of the Java Memory Model

- Java’s memory model defines semantics of multi-threaded access to shared memory, e.g.
  - Which instruction reorderings are allowed in memory
  - Should not be overly restrictive, to enable hardware optimizations

![Diagram illustrating the Java Memory Model]

\[ x = y = 0 \]

\[ x = 1 \]

\[ j = y \]

\[ y = 1 \]

\[ i = x \]

\[ x = y = 0 \]

\[ i = 0 \] \& \[ j = 0 \] due to local caching effects in \( \text{Thread}_1 \) \& \( \text{Thread}_2 \)

See [en.wikipedia.org/wiki/Memory_ordering](https://en.wikipedia.org/wiki/Memory_ordering)
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- Java’s memory model defines semantics of multi-threaded access to shared memory, e.g.
- Which instruction reorderings are allowed in memory
- Which program outputs may occur in a correct JVM implementation

See docs.oracle.com/javase/specs/jls/se7/html/jls-17.html#jls-17.4.3
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- Java’s memory model defines semantics of multi-threaded access to shared memory, e.g.
  - Which instruction reorderings are allowed in memory
  - Which program outputs may occur in a correct JVM implementation
  - Reordering should not be so generous such that values appear randomly!

```
x = y = 0
r1 = x
y = r1
x = r2
r2 = y
```

```
Thread_1
\text{start threads}
```

```
Thread_2
x = r2
y = r1
r1 = x
```

```
Must not result in \( r1 = r2 = 42 \)!
```

See simple.wikipedia.org/wiki/42_(answer)
Overview of the Java Memory Model

• Reading about Java’s memory model is as much fun as watching paint dry..

See www.cs.umd.edu/users/pugh/java/memoryModel/jsr-133-faq.html
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- Reading about Java’s memory model is as much fun as watching paint dry..

Fortunately, you needn’t understand all these memory model details – you just need to know how to use Java synchronizers properly!!
End of Overview of the Java Memory Model