Overview of Concurrent Programming Concepts

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Learning Objectives in this Part of the Lesson

• Understand the meaning of key concurrent programming concepts
An Overview of Sequential Programming
An Overview of Sequential Programming

- Sequential programming is a form of computing that executes the same sequence of instructions & always produces the same results.

See en.wikipedia.org/wiki/Sequential_algorithm
An Overview of Sequential Programming

- Sequential programming is a form of computing that executes the same sequence of instructions & always produces the same results
- i.e., execution is deterministic

See [screenprism.com/insights/article/what-is-the-ludovico-technique-and-how-does-it-work](screenprism.com/insights/article/what-is-the-ludovico-technique-and-how-does-it-work)
An Overview of Sequential Programming

• Sequential programs have two characteristics
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• Sequential programs have two characteristics:

• The textual order of statements specifies their order of execution

```java
public E get(int index) {
    rangeCheck(index);
    return elementData(index);
}
```

e.g., the `rangeCheck()` method **must be called before the `elementData()` method**

See `src/share/classes/java/util/ArrayList.java`
An Overview of Sequential Programming

• Sequential programs have two characteristics:
  • The textual order of statements specifies their order of execution
  • Successive statements must execute without any temporal overlap
An Overview of Concurrent Programming
An Overview of Concurrent Programming

- Concurrent programming is a form of computing where threads can run simultaneously.

See [en.wikipedia.org/wiki/Concurrency_(computer_science)](en.wikipedia.org/wiki/Concurrency_(computer_science))
An Overview of Concurrent Programming

- Concurrent programming is a form of computing where threads can run simultaneously.

```java
for (int i = 0; i < sMax; i++)
    new Thread(() ->
        someComputation()).start();
```

A thread is a unit of execution for instruction streams that can run concurrently on 1+ processor cores.

See [docs.oracle.com/javase/tutorial/essential/concurrency/threads.html](docs.oracle.com/javase/tutorial/essential/concurrency/threads.html)
An Overview of Concurrent Programming

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```java
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    new Thread(() ->
        someComputation()).start();
```

*Threads may be multiplexed over one core, though this is increasingly rare.*

An Overview of Concurrent Programming

- Different executions of a concurrent program may produce different instruction orderings

See en.wikipedia.org/wiki/Nondeterministic_algorithm
• Different executions of a concurrent program may produce different instruction orderings:
  
  • The textual order of the source code doesn’t define the order of execution
  
  new Thread(() ->
    computationA().
    start();

  new Thread(() ->
    computationB().
    start();

  new Thread(() ->
    computationC().
    start();

  computationA(), computationB(), & computationC() can run in any order after their threads start executing
Different executions of a concurrent program may produce different instruction orderings:

- The textual order of the source code doesn’t define the order of execution
- Operations are permitted to overlap in time
Concurrent programming is often used to offload work from the user interface (UI) thread to background thread(s).

See developer.android.com/topic/performance/threads.html
An Overview of Concurrent Programming

• Concurrent programming is often used to offload work from the user interface (UI) thread to background thread(s), e.g.
• Background thread(s) can block

See developer.android.com/training/multiple-threads/communicate-ui.html
An Overview of Concurrent Programming

- Concurrent programming is often used to offload work from the user interface (UI) thread to background thread(s), e.g.
  - Background thread(s) can block
  - The UI thread does not block

See [developer.android.com/training/multiple-threads/communicate-ui.html](http://developer.android.com/training/multiple-threads/communicate-ui.html)
Concurrent programming is often used to offload work from the user interface (UI) thread to background thread(s), e.g.

- Background thread(s) can block
- The UI thread does not block
- Any mutable state shared between these threads must be protected to avoid concurrency hazards

See upcoming lesson on “Overview of Concurrency in Java”
End of Overview of Concurrent Programming Concepts