Overview of Java 8 Functional Interfaces

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Learning Objectives in this Lesson

- Recognize foundational functional programming features in Java 8, e.g.,
  - Lambda expressions
  - Method & constructor references
  - Functional interfaces

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  - Lambda expressions
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  - Functional interfaces

These features are the foundation for Java 8's concurrency/parallelism frameworks

Learning Objectives in this Lesson

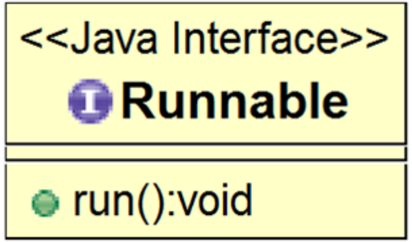
- Recognize foundational functional programming features in Java 8
- Understand how these Java 8 features are applied in concise example programs

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8

Overview of Common Functional Interfaces

Overview of Common Functional Interfaces

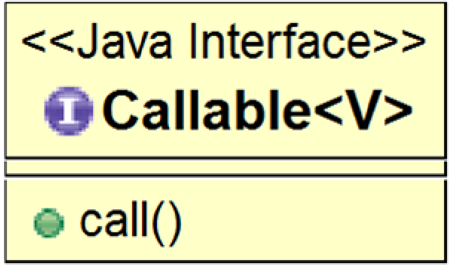
- A *functional interface* contains only one abstract method



<<Java Interface>>

Runnable

● run():void



<<Java Interface>>

Callable<V>

● call()

See www.oreilly.com/learning/java-8-functional-interfaces

Overview of Common Functional Interfaces

- A functional interface is the type used for a parameter when a lambda expression or method reference is passed as an argument

```
<T> void runTest(Function<T, T> fact, T n) {
  System.out.println(n + " factorial = " + fact.apply(n));
}

runTest(ParallelStreamFactorial::factorial, n);

...
```

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex16

Overview of Common Functional Interfaces

- A functional interface is the type used for a parameter when a lambda expression or method reference is passed as an argument

```
<T> void runTest(Function<T, T> fact, T n) {
  System.out.println(n + " factorial = " + fact.apply(n));
}

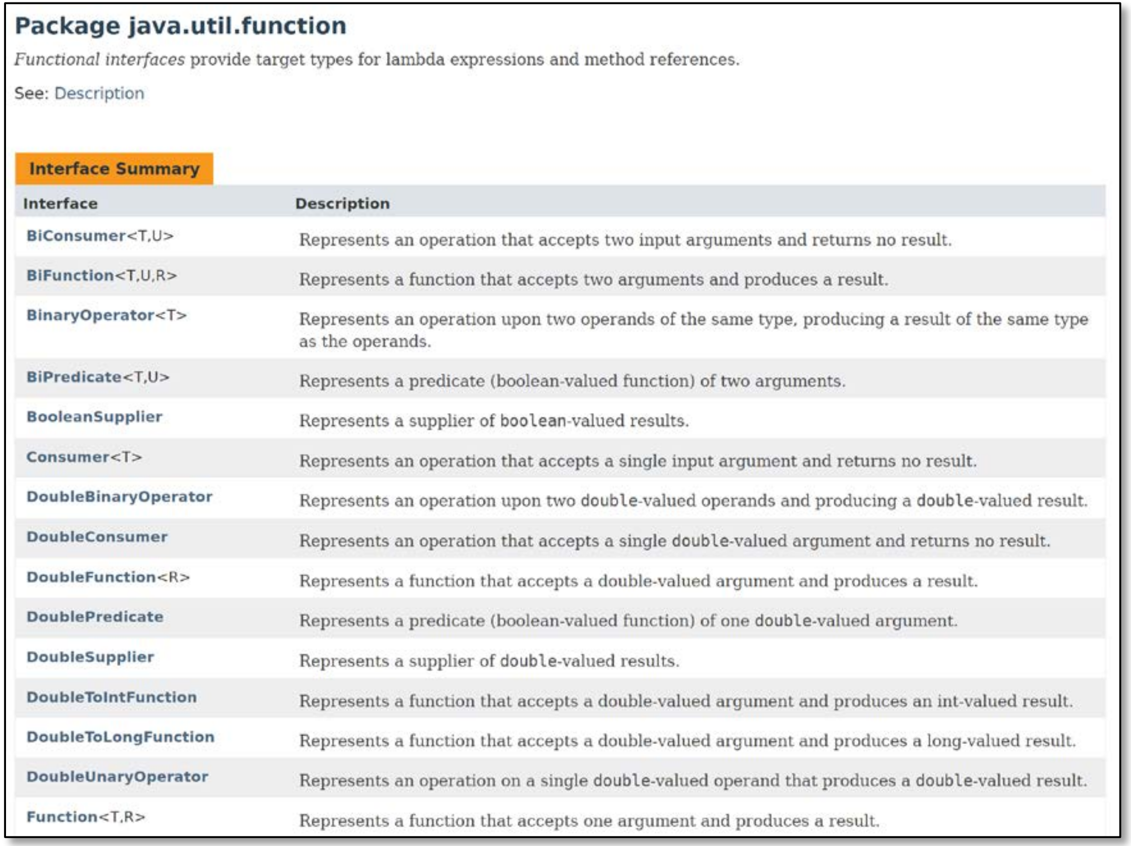
runTest(ParallelStreamFactorial::factorial, n);

...
```

```
static BigInteger factorial(BigInteger n) { return LongStream
    .rangeClosed(1, n)
    .parallel()
    .mapToObj(BigInteger::valueOf)
    .reduce(BigInteger.ONE, BigInteger::multiply);
}
```

Overview of Common Functional Interfaces

- Java 8 defines many types of functional interfaces



Package java.util.function

Functional interfaces provide target types for lambda expressions and method references.

See: Description

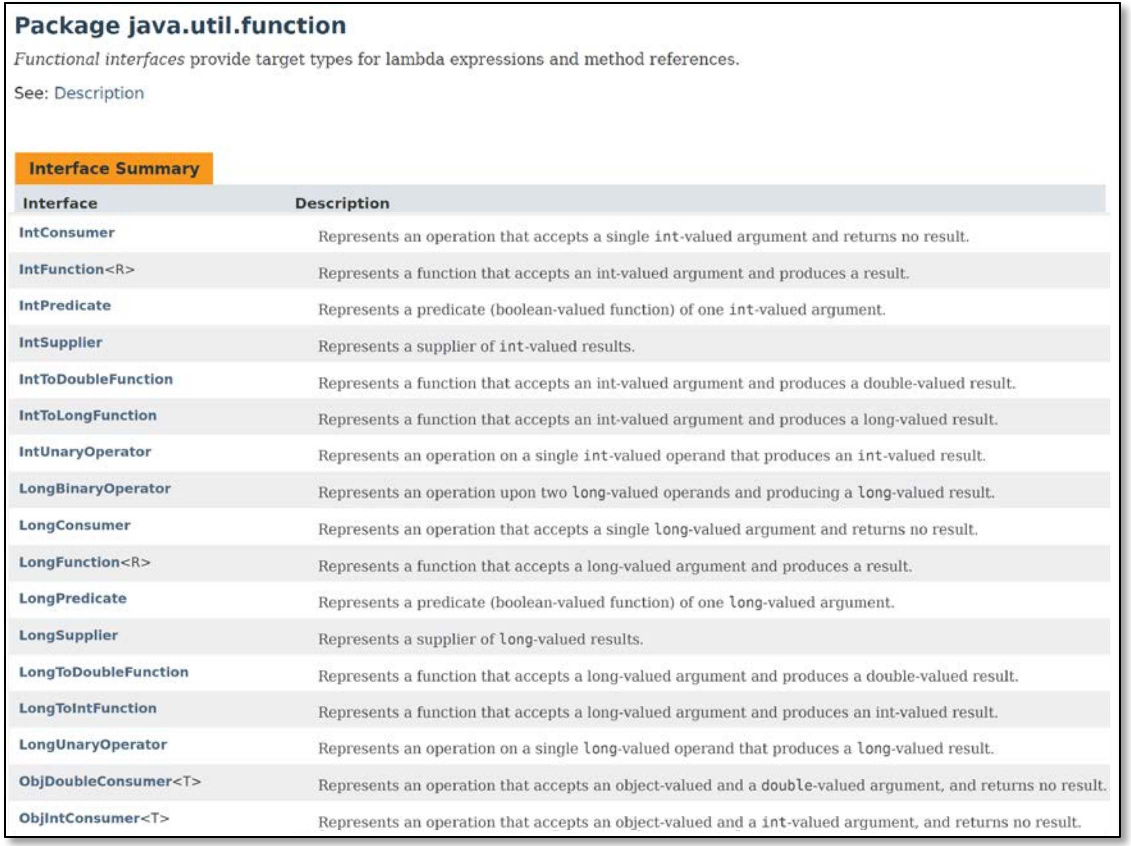
Interface Summary

Interface	Description
BiConsumer<T,U>	Represents an operation that accepts two input arguments and returns no result.
BiFunction<T,U,R>	Represents a function that accepts two arguments and produces a result.
BinaryOperator<T>	Represents an operation upon two operands of the same type, producing a result of the same type as the operands.
BiPredicate<T,U>	Represents a predicate (boolean-valued function) of two arguments.
BooleanSupplier	Represents a supplier of boolean-valued results.
Consumer<T>	Represents an operation that accepts a single input argument and returns no result.
DoubleBinaryOperator	Represents an operation upon two double-valued operands and producing a double-valued result.
DoubleConsumer	Represents an operation that accepts a single double-valued argument and returns no result.
DoubleFunction<R>	Represents a function that accepts a double-valued argument and produces a result.
DoublePredicate	Represents a predicate (boolean-valued function) of one double-valued argument.
DoubleSupplier	Represents a supplier of double-valued results.
DoubleToIntFunction	Represents a function that accepts a double-valued argument and produces an int-valued result.
DoubleToLongFunction	Represents a function that accepts a double-valued argument and produces a long-valued result.
DoubleUnaryOperator	Represents an operation on a single double-valued operand that produces a double-valued result.
Function<T,R>	Represents a function that accepts one argument and produces a result.

See docs.oracle.com/javase/8/docs/api/java/util/function/package-summary.html

Overview of Common Functional Interfaces

- Java 8 defines many types of functional interfaces
  - The need to support both reference types & primitive types increases this list..



Package java.util.function

Functional interfaces provide target types for lambda expressions and method references.

See: Description

Interface Summary

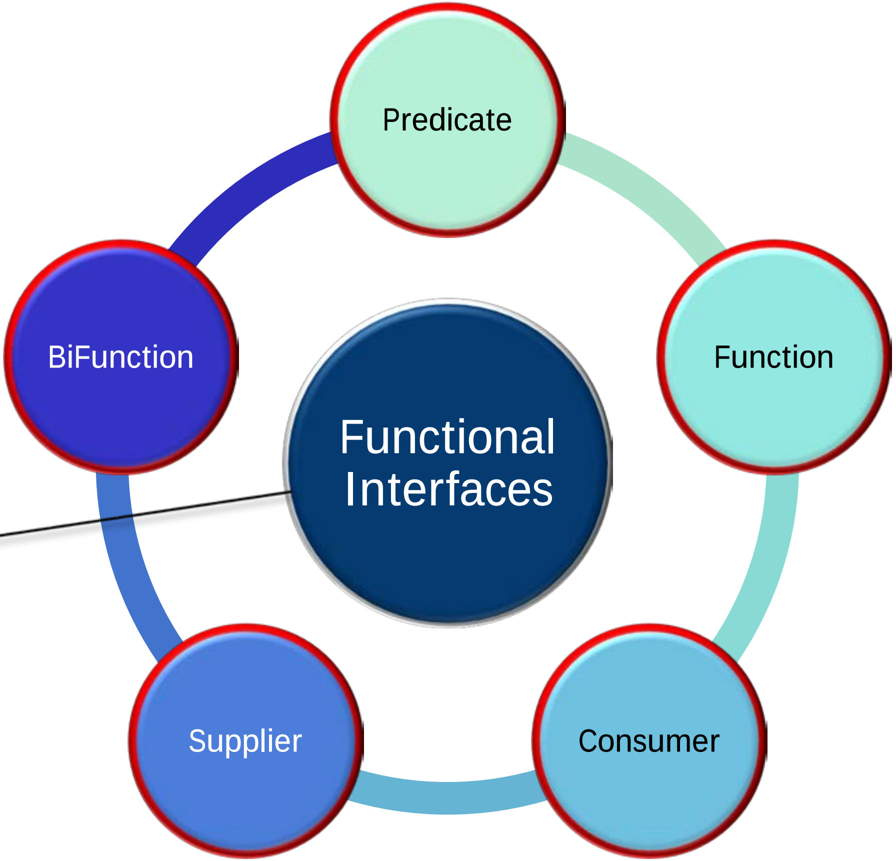
Interface	Description
IntConsumer	Represents an operation that accepts a single `int`-valued argument and returns no result.
IntFunction<R>	Represents a function that accepts an int-valued argument and produces a result.
IntPredicate	Represents a predicate (boolean-valued function) of one `int`-valued argument.
IntSupplier	Represents a supplier of `int`-valued results.
IntToDoubleFunction	Represents a function that accepts an int-valued argument and produces a double-valued result.
IntToLongFunction	Represents a function that accepts an int-valued argument and produces a long-valued result.
IntUnaryOperator	Represents an operation on a single `int`-valued operand that produces an `int`-valued result.
LongBinaryOperator	Represents an operation upon two `long`-valued operands and producing a `long`-valued result.
LongConsumer	Represents an operation that accepts a single `long`-valued argument and returns no result.
LongFunction<R>	Represents a function that accepts a long-valued argument and produces a result.
LongPredicate	Represents a predicate (boolean-valued function) of one `long`-valued argument.
LongSupplier	Represents a supplier of `long`-valued results.
LongToDoubleFunction	Represents a function that accepts a long-valued argument and produces a double-valued result.
LongToIntFunction	Represents a function that accepts a long-valued argument and produces an int-valued result.
LongUnaryOperator	Represents an operation on a single `long`-valued operand that produces a `long`-valued result.
ObjDoubleConsumer<T>	Represents an operation that accepts an object-valued and a `double`-valued argument, and returns no result.
ObjIntConsumer<T>	Represents an operation that accepts an object-valued and a `int`-valued argument, and returns no result.

See dzone.com/articles/whats-wrong-java-8-part-ii

Overview of Common Functional Interfaces

- Java 8 defines many types of functional interfaces
  - The need to support both reference types & primitive types increases this list..

We focus on the most common types of functional interfaces



Overview of Common Functional Interfaces

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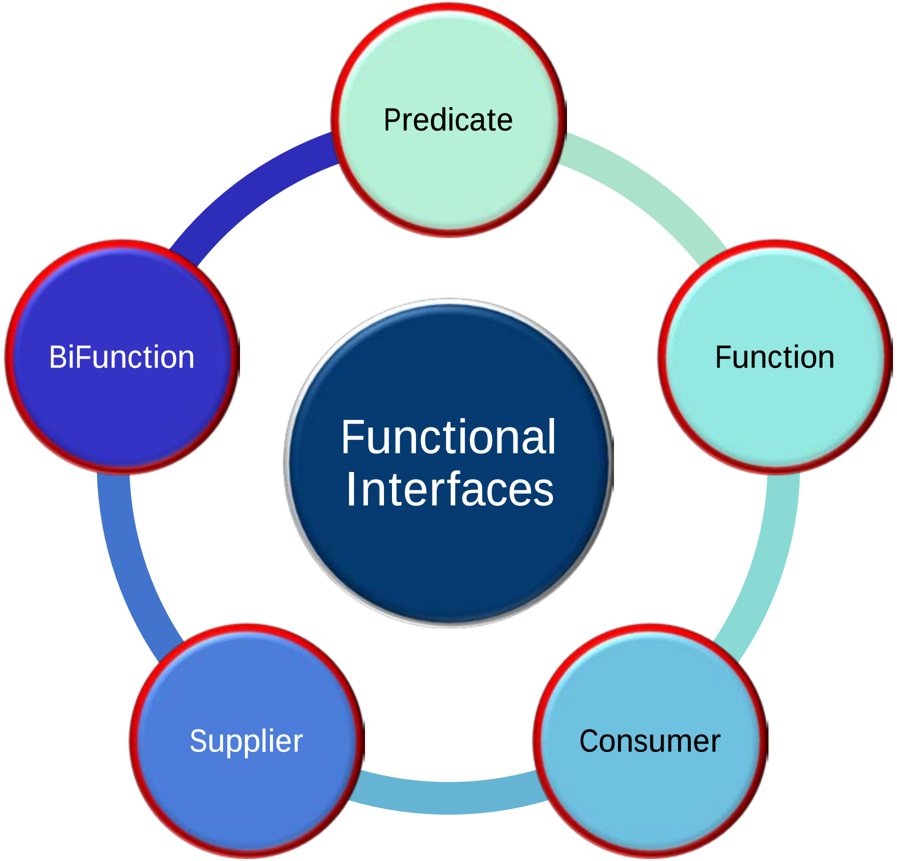

Note how all the functional interfaces in the upcoming examples "stateless"!

Overview of Functional Interfaces: Predicate, Function, & BiFunction

Overview of Common Functional Interfaces: Predicate

- A *Predicate* performs a test that returns true or false, e.g.,
  - **`public interface Predicate<T> { boolean test(T t); }`**

See docs.oracle.com/javase/8/docs/api/java/util/function/Predicate.html

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```
Map<String, Integer> iqMap =
   new ConcurrentHashMap<String, Integer>() { {
     put("Larry", 100); put("Curly", 90); put("Moe", 110);
   }
};

System.out.println(iqMap);

iqMap.entrySet().removeIf(entry -> entry.getValue() <= 100);

System.out.println(iqMap);
```

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex10

Overview of Common Functional Interfaces: Predicate

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   }
};

System.out.println(iqMap);

iqMap.entrySet().removeIf(entry -> entry.getValue() <= 100);

System.out.println(iqMap);
```

This predicate lambda deletes entries with iq <= 100

Overview of Common Functional Interfaces: Predicate

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   }
};

System.out.println(iqMap);

iqMap.entrySet().removeIf(entry -> entry.getValue() <= 100);

System.out.println(iqMap);
```

entry is short for (EntrySet entry), which leverages the type inference capabilities of Java 8's compiler

See docs.oracle.com/javase/tutorial/java/generics/genTypeInference.html

Overview of Common Functional Interfaces: Function

- A *Function* applies a computation on 1 parameter & returns a result, e.g.,
  - `public interface Function<T, R> { R apply(T t); }`

See docs.oracle.com/javase/8/docs/api/java/util/function/Function.html

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```
Map<Integer, Integer> primeCache =
  new ConcurrentHashMap<>();

...
Long smallestFactor = primeCache.computeIfAbsent
    (primeCandidate, (key) -> primeChecker(key));
...

Integer primeChecker(Integer primeCandidate) {
  ... // Determines if a number if prime
}
```

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex9

Overview of Common Functional Interfaces: Function

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  new ConcurrentHashMap<>();

...
Long smallestFactor = primeCache.computeIfAbsent
    (primeCandidate, (key) -> primeChecker(key));
...

Integer primeChecker(Integer primeCandidate) {
  ... // Determines if a number if prime
}
```

This method provides atomic "check then act" semantics

See dig.cs.illinois.edu/papers/checkThenAct.pdf

Overview of Common Functional Interfaces: Function

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  new ConcurrentHashMap<>();

...
Long smallestFactor = primeCache.computeIfAbsent
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...

Integer primeChecker(Integer primeCandidate) {
  ... // Determines if a number if prime
}
```

A lambda expression that calls a function

Overview of Common Functional Interfaces: Function

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```
Map<Integer, Integer> primeCache =
  new ConcurrentHashMap<>();


...
Long smallestFactor = primeCache.computeIfAbsent
    (primeCandidate, this::primeChecker);
...

Integer primeChecker(Integer primeCandidate) {
  ... // Determines if a number if prime
}
```

Could also be a passed as a method reference

Overview of Common Functional Interfaces: BiFunction

- A *BiFunction* applies a computation on 2 parameters & returns a result, e.g.,
  - `public interface BiFunction<T, U, R> { R apply(T t, U u); }`

See docs.oracle.com/javase/8/docs/api/java/util/function/BiFunction.html

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```
Map<String, Integer> iqMap =
  new ConcurrentHashMap<String, Integer>() {
    { put("Larry", 100); put("Curly", 90); put("Moe", 110); }
};

for (Map.Entry<String, Integer> entry : iqMap.entrySet())
   entry.setValue(entry.getValue() - 50);
```

vs.

```
iqMap.replaceAll((k, v) -> v - 50);
```

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex4

Overview of Common Functional Interfaces: BiFunction

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};

for (Map.Entry<String, Integer> entry : iqMap.entrySet())
   entry.setValue(entry.getValue() - 50);
```

Conventional way of subtracting 50 IQ points from each person in map

vs.

```
iqMap.replaceAll((k, v) -> v - 50);
```

Overview of Common Functional Interfaces: BiFunction

- A *BiFunction* applies a computation on 2 parameters & returns a result, e.g.,
  - `public interface BiFunction<T, U, R> { R apply(T t, U u); }`

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};

for (Map.Entry<String, Integer> entry : iqMap.entrySet())
   entry.setValue(entry.getValue() - 50);
```

vs.

```
iqMap.replaceAll((k, v) -> v - 50);
```

BiFunctional lambda subtracts 50 IQ points from each person in map

Unlike the Entry operations, replaceAll() operates in a thread-safe manner!

Overview of Functional Interfaces: Consumer & Supplier

Overview of Common Functional Interfaces: Consumer

- A *Consumer* accepts a parameter & returns no results, e.g.,
  - **`public interface Consumer<T> { void accept(T t); }`**

See docs.oracle.com/javase/8/docs/api/java/util/function/Consumer.html

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Overview of Common Functional Interfaces: Consumer

- A *Consumer* accepts a parameter & returns no results, e.g.,
  - **`public interface Consumer<T> { void accept(T t); }`**

```
List<Thread> threads =
  Arrays.asList(new Thread("Larry"),
                new Thread("Curly"),
                new Thread("Moe"));
threads.forEach(System.out::println);
threads.sort(Comparator.comparing(Thread::getName));
threads.forEach(System.out::println);
```

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex5

Overview of Common Functional Interfaces: Consumer

- A *Consumer* accepts a parameter & returns no results, e.g.,
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                new Thread("Curly"),
                new Thread("Moe"));
threads.forEach(System.out::println);
threads.sort(Comparator.comparing(Thread::getName));
threads.forEach(System.out::println);
```

Print out threads using forEach()

See docs.oracle.com/javase/8/docs/api/java/lang/Iterable.html#forEach-java.util.function.Consumer-

Overview of Common Functional Interfaces: Supplier

- A *Supplier* returns a value & takes no parameters, e.g.,
  - **`public interface Supplier<T> { T get(); }`**

See docs.oracle.com/javase/8/docs/api/java/util/function/Supplier.html

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- A *Supplier* returns a value & takes no parameters, e.g.,
  - `public interface Supplier<T> { T get(); }`

```
Map<String, String> beingMap = new HashMap<String, String>()
{ { put("Demon", "Naughty"); put("Angel", "Nice"); } };

String being = ...;

Optional<String> disposition =
  Optional.ofNullable(beingMap.get(being));

System.out.println("disposition of "
                   + being + " = "
                   + disposition.orElseGet(() -> "unknown"));
```

Returns default value if being not found

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex6

Overview of Common Functional Interfaces: Supplier

- A *Supplier* returns a value & takes no parameters, e.g.,
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String being = ...;

Optional<String> disposition =
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System.out.println("disposition of "
                   + being + " = "
                   + disposition.orElseGet(() -> "unknown"));
```

Returns default value if being not found

See docs.oracle.com/javase/8/docs/api/java/util/Optional.html

Overview of Common Functional Interfaces: Supplier

- A constructor reference is also a *Supplier*, e.g.,
  - **`public interface Supplier<T> { T get(); }`**

```
class CrDemo {
    public static void main(String[] argv) {
        Supplier<CrDemo> supplier = CrDemo::new;
        System.out.println(supplier.get().hello());
    }

    private String hello() {
        return "hello";
    }
}
```

See github.com/douglascraigschmidt/LiveLessons/tree/master/Java8/ex7

Overview of Common Functional Interfaces: Supplier

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        System.out.println(supplier.get().hello());
    }

    private String hello() {
        return "hello";
    }
}
```

Create a supplier object that's initialized with a constructor reference for class CrDemo

See www.speakingcs.com/2014/08/constructor-references-in-java-8.html

Overview of Common Functional Interfaces: Supplier

- A constructor reference is also a *Supplier*, e.g.,
  - `public interface Supplier<T> { T get(); }`

```
class CrDemo {
    public static void main(String[] argv) {
        Supplier<CrDemo> supplier = CrDemo::new;
        System.out.println(supplier.get().hello());
    }

    private String hello() {
        return "hello";
    }
}
```

Calls a method in CrDemo

End of Overview of Java 8 Functional Interfaces