Código funcional em Java: Superando o hype

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Lambda Expressions 101

Dora

Bento

```
public Pug( String nome,
            String color,
            Integer size ) {
    this.nome = nome;
    this.color = color;
    this.weight = size;
}
```

```
Pug dora = new Pug( "Dora", "abricot", 10 );
Pug bento = new Pug( "Bento", "abricot", 13 );
Pug jesse = new Pug( "Jesse", "black", 9 );
```

Requisito:

Filtrar todos os pugs de cor “abricot" da lista

Filtrar todos os pugs de cor “abricot" da lista

```
private static List<Pug> filterAbricotPugs( List<Pug> pugs ) {
       List<Pug> abricots = new ArrayList<>();
       for ( Pug pug : pugs ) {
           if ( pug.getColor().equals( "abricot" ) ) {
               abricots.add( pug );
           }

       }
       return abricots;
   }
```

```
List<Pug> pugs = Arrays.asList( dora, bento, jesse );

List<Pug> abricot = filterAbricotPugs( pugs );
```

```
Pug{nome='Dora', color='abricot', weight=10}
Pug{nome='Bento', color='abricot', weight=13}
```

Novo Requisito: :)

Filtrar todos os pugs de cor “black" da lista

```java
private static List<Pug> filterAbricotPugs( List<Pug> pugs ) {
       List<Pug> abricots = new ArrayList<>();
       for ( Pug pug : pugs ) {
           if ( pug.getColor().equals( "abricot" ) ) {
               abricots.add( pug );
           }

       }
       return abricots;
   }


private static List<Pug> filterBlackPugs( List<Pug> pugs ) {
       List<Pug> abricots = new ArrayList<>();
       for ( Pug pug : pugs ) {
           if ( pug.getColor().equals( "black" ) ) {
               abricots.add( pug );
           }

       }
       return abricots;
   }
```

Filtrar todos os pugs de cor “black" da lista

```
private static List<Pug> filterPugByColor( List<Pug> pugs,
                                           String color ) {

    List<Pug> coloured = new ArrayList<>();
        for ( Pug pug : pugs ) {
            if ( pug.getColor().equals( color ) ) {
                coloured.add( pug );
            }

        }
        return coloured;

}
```

```
List<Pug> black = filterPugByColor( pugs, "black" );

black.forEach( System.out::println );
```

```
Pug{nome='Jesse', color='black', weight=9}
```

Novo Requisito: :)

Filtrar todos os pugs com sobrepeso (>10 kg)

Filtrar todos os pugs com sobrepeso (>10 kg)

```
private static List<Pug> filterPugBySize( List<Pug> pugs,
                                                  int size ) {
      List<Pug> fat = new ArrayList<>();
      for ( Pug pug : pugs ) {
          if ( pug.getWeight() > size ) {
              fat.add( pug );
          }

      }
      return fat;
  }
```

```
List<Pug> fat = filterPugBySize( pugs, 10 );

fat.forEach( System.out::println );
```

```
Pug{nome='Bento', color='abricot', weight=13}
```

Refatorador :D

```
private static List<Pug> filterPugs( List<Pug> pugs,
                                     String color,
                                     int weight,
                                     boolean flag ) {
    List<Pug> result = new ArrayList<>();
    for ( Pug pug : pugs ) {
        if ( ( flag && pug.getColor().equals( color ) ) ||
                ( !flag && pug.getWeight() > weight ) ) {
            result.add( pug );
        }

    }
    return result;
}
```

```
List<Pug> result = filterPugs(pugs, "black", 0, true);
List<Pug> result1 = filterPugs(pugs, "", 10, false);
```

Behavior Parametrization

Behavior Parametrization

```
public interface PugPredicate {
    boolean test(Pug pug);
}
```

```
class BlackPugPredicate implements  PugPredicate{

    @Override
    public boolean test( Pug pug ) {
        return pug.getColor().equals( "black" );
    }
}

class FatPugPredicate implements  PugPredicate{

    @Override
    public boolean test( Pug pug ) {
        return pug.getWeight()>10;
    }
}
```

Predicate

```
List<Pug> black = filterPug( pugs,
                    new BlackPugPredicate() );

List<Pug> fat = filterPug( pugs,
                    new FatPugPredicate() );

fat.forEach( System.out::println );
```

```
Pug{nome='Bento', color='abricot',
weight=13}
```

Classes anônimas

<3

```java
List<Pug> abricotsNotFat =

       filterPug( pugs, new PugPredicate() {
           @Override
           public boolean test( Pug pug ) {

           return pug.getColor().equals( "abricot" )
                  && pug.getWeight() <= 10;
           }
       } );

       abricotsNotFat.forEach( System.out::println );
```

```
Pug{nome='Dora', color='abricot', weight=10}
```

Expressões Lambda

<3

"Arrow"

```
(Pug p1,Pug p2) -> p1.getWeight().compareTo(p2.getWeight())
```

Parâmetros
do
Lambda

Corpo
do
Lambda

```
class BlackPugPredicate implements  PugPredicate{

    @Override
    public boolean test( Pug pug ) {
        return "black".equals( pug.getColor() ) );
    }
}
```

```
blacks = filterPug( pugs, new BlackPugPredicate() );
```

```
blacks = filterPug( pugs,

     (Pug pug) ->"black".equals( pug.getColor() ) );
```

Posso modificar mais um pouco?

```java
public interface Predicate<T>{
   boolean test(T t);
}


public static <T> List<T> filter
                  (List<T> list, Predicate<T> p){

  List<T> result = new ArrayList<>();

  for(T e: list){
      if(p.test(e)){
        result.add(e);
      }
  }

  return result;

}
```

```java
List<Pug> blacks =
  filter( pugs,
    (Pug pug) ->"black".equals( pug.getColor() ) );
```

```java
List<Integer> pares =
  filter(numbers,
         i -> i % 2 == 0);
```

```java
Predicate<Pug> fatPredicate = d -> d.getWeight() > 9;
Predicate<Pug> abricotPredicate1 =
               d -> d.getColor().equalsIgnoreCase( "abricot" );
Predicate<Pug> abricotAndFat =
                 abricotPredicate.and( fatPredicate );
```

Predicate

```
@FunctionalInterface
public interface Predicate<T>{
   boolean test(T t);
}

public static <T> List<T> filter(List<T> list, Predicate<T> p) {
   List<T> results = new ArrayList<>();
   for(T s: list){
        if(p.test(s)){
          results.add(s);
      }
   }
   return results;
}

Predicate<String> nonEmptyStringPredicate = (String s) -> !s.isEmpty();
List<String> nonEmpty = filter(listOfStrings, nonEmptyStringPredicate);
```

Consumer

```
public class ShoppingCartTest {

    ShoppingCart cart;

    @Before
    public void setup() {
        Item item1 = new Item( 10 );
        Item item2 = new Item( 20 );
        cart = new ShoppingCart( Arrays.asList( item1, item2 ) );
    }

    @Test
    public void totalTest() {
        cart.pay( ShoppingCart.PaymentMethod.CREDIT ) );
    }
}
```

```java
public class ShoppingCart {

    private List<Item> items;

     public ShoppingCart( List<Item> items ) {
         this.items = items;
     }

     public void pay( PaymentMethod method ) {
         int total = cartTotal();
         if ( method == PaymentMethod.CREDIT ) {
             System.out.println( “Pay with credit “ + total );
         } else if ( method == PaymentMethod.MONEY ) {
             System.out.println( “Pay with money “ + total );
         }
     }

      private int cartTotal() {
         return  items
                 .stream()
                 .mapToInt( Item::getValue )
                 .sum();
     }

…
}
```

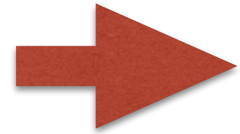
```java
public interface Payment {

    public void pay(int amount);

}
```

```java
public class CreditCard implements Payment {
    @Override
    public void pay( int amount ) {
        System.out.println( "Pay with Credit: “+ amount);
    }
}
```

```java
public class Money implements Payment {
    @Override
    public void pay( int amount ) {
        System.out.println( "Pay with Money: “+ amount);
}
```



```
public class ShoppingCart {
    …
    public void pay( Payment method ) {
        int total = cartTotal();
        method.pay( total );
    }

        private int cartTotal() {
         return  items
                 .stream()
                 .mapToInt( Item::getValue )
                 .sum();
    }
}
```

Strategy

"Definir uma família de algoritmos, encapsular cada uma delas e torná-las intercambiáveis. Strategy permite que o algoritmo varie independentemente dos clientes que o utilizam" GAMMA, Erich et al.

```
public interface Payment {

    public void pay(int amount);

}
```

```
public class CreditCard implements Payment {
    @Override
    public void pay( int amount ) {
        System.out.println( "make credit

payment logic" );
    }
}
```

```
public class Money implements Payment {
    @Override
    public void pay( int amount ) {
        System.out.println( "make money

    }
}
```

```
public class DebitCard implements Payment {
    @Override
    public void pay( int amount ) {
        System.out.println( "make debit
payment logic" );
    }
}
```

```
    public void totalTest() {
        assertEquals( 30, cart.pay( new CreditCard() ) );
        assertEquals( 30, cart.pay( new Money() ) );
        assertEquals( 30, cart.pay( new DebitCard() ) );
    }
}
```

java.util.function

Interface Consumer<T>

Type Parameters:

T - the type of the input to the operation

All Known Subinterfaces:

Stream.Builder<T>

Functional Interface:

This is a functional interface and can therefore be used as the assignment target for a lambda expression or method reference.

All Methods | **Instance Methods** | **Abstract Methods** | **Default Methods**

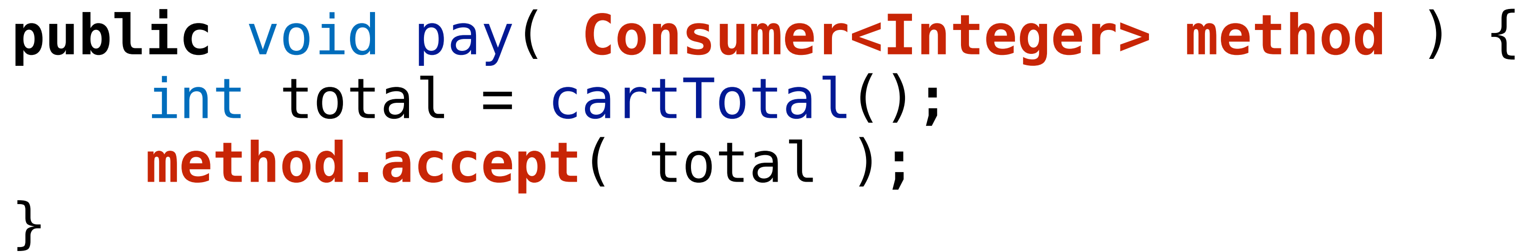
Modifier and Type	Method and Description
void	accept(T t) Performs this operation on the given argument.
default Consumer<T>	andThen(Consumer<? super T> after) Returns a composed Consumer that performs, in sequence, this operation followed by the after operation.

```java
public void pay( Payment method ) {
    int total = cartTotal();
    method.pay( total );
}
```

```java
public class ShoppingCart {
    …

    public void pay( Consumer<Integer> method ) {
        int total = cartTotal();
        method.accept( total );
    }
    …
}
```

```java
public class ShoppingCart {
        …
```



```java
    public void pay( Consumer<Integer> method ) {
        int total = cartTotal();
        method.accept( total );
    }
```

```java
        …
}
```

```java
public void totalTest() {
    cart.pay( amount ->
                System.out.println( "Pay with Credit: " + amount ) );
    cart.pay( amount ->
                System.out.println( "Pay with Money: " + amount ) );
    cart.pay( amount ->
                System.out.println( "Pay with Debit: " + amount ) );
}
```

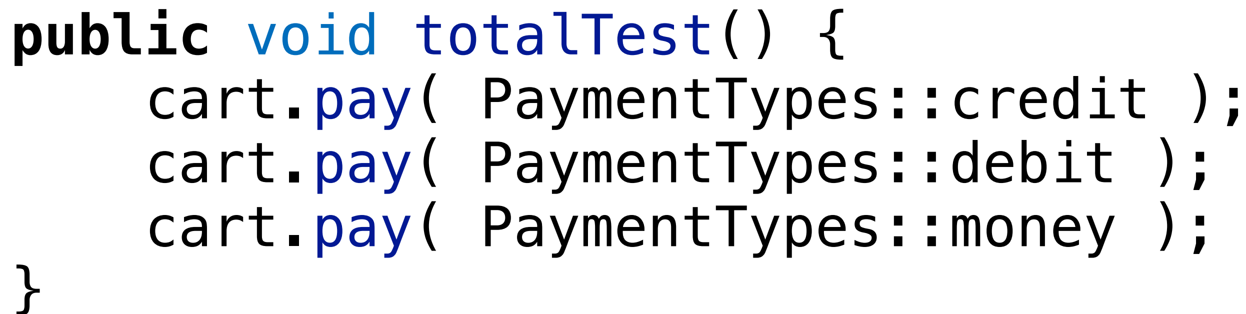
```java
public class PaymentTypes {

    public static void money( int amount ) {
        System.out.println( "Pay with Money: " + amount );
    }

    public static void debit( int amount ) {
        System.out.println( "Pay with Debit: " + amount );
    }

    public static void credit( int amount ) {
        System.out.println( "Pay with Credit: " + amount );
    }

}
```



```java
public class ShoppingCart {
    …
    public void pay( Consumer<Integer> method ) {
        int total = cartTotal();
        method.accept( total );
    }

    …
}
```

Strategy

Happy Pug

is happy

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Functions

Interface Function<T,R>

Type Parameters:

T - the type of the input to the function

R - the type of the result of the function

All Known Subinterfaces:

UnaryOperator<T>

Functional Interface:

This is a functional interface and can therefore be used as the assignment target for a lambda expression or method reference.

```
@FunctionalInterface
public interface Function<T,R>
```

Represents a function that accepts one argument and produces a result.

This is a functional interface whose functional method is `apply(Object)`.

Since:

1.8

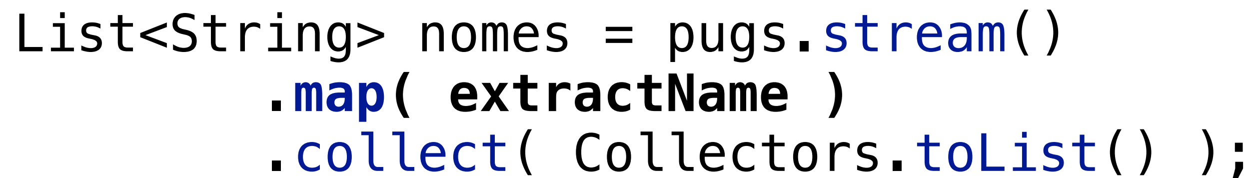
Method Summary

All Methods | **Static Methods** | **Instance Methods** | **Abstract Methods** | **Default Methods**

Modifier and Type	Method and Description
default <V> Function<T,V>	andThen(Function<? super R,? extends V> after) Returns a composed function that first applies this function to its input, and then applies the `after` function to the result.
R	apply(T t) Applies this function to the given argument.
default <V> Function<V,R>	compose(Function<? super V,? extends T> before) Returns a composed function that first applies the `before` function to its input, and then applies this function to the result.
static <T> Function<T,T>	identity() Returns a function that always returns its input argument.

```
List<Pug> pugs = Arrays.asList( dora, bento, jesse );
```

```
Function<Pug, String> extractName = pug -> pug.getName();
```

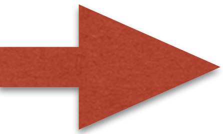


```
List<String> nomes = pugs.stream()
        .map( extractName )
        .collect( Collectors.toList() );

print( nomes );
```

Dora
Bento
Jesse

```
List<Pug> pugs = Arrays.asList( dora, bento, jesse );


Function<Pug, String> extractName = pug -> pug.getName();

List<String> nomes = pugs.stream()
        .map( extractName )
        .collect( Collectors.toList() );

print( nomes );
```

```java
List<Pug> pugs = Arrays.asList( dora, bento, jesse );

Function<Pug, String> extractName = pug -> pug.getName();

List<String> nomes = pugs.stream()
        .map( extractName )
        .collect( Collectors.toList() );

print( nomes );

UnaryOperator<String> upper = s -> s.toUpperCase();

List<String> nomesUpper = pugs.stream()
        .map( extractName.andThen( upper ) )
        .collect( Collectors.toList() );

print( nomesUpper );
```

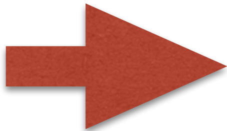


```java
public class Item {
    private int price;

    public Item( int price ) {
        this.price = price;
    }

    public int getPrice() {
        return price;
    }
}
```

Extras

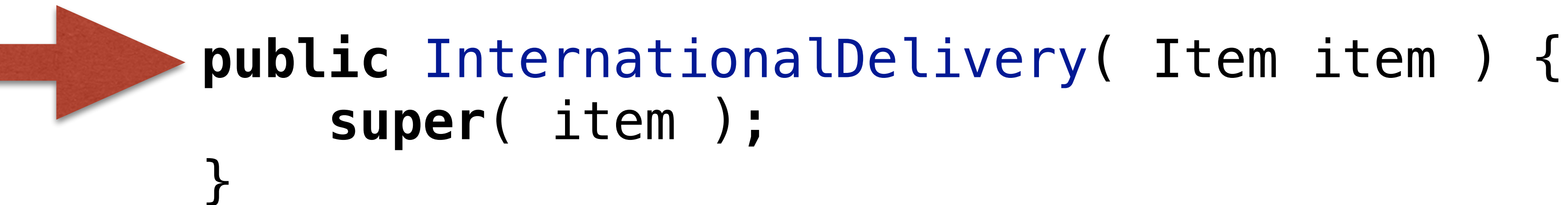
Envio
Impostos
Embalagem

```java
public interface Item {
    int getPrice();
}


public class Book implements Item {
    private int price;

    public Book( int price ) {
        this.price = price;
    }

    @Override
    public int getPrice() {
        return price;
    }
}
```



```
public abstract class ItemExtras implements Item {

    private Item item;

    public ItemExtras( Item item ) {
        this.item = item;
    }

    @Override
    public int getPrice() {
        return item.getPrice();
    }
}
```

```java
public class InternationalDelivery extends ItemExtras {
```

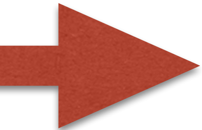


```java
    public InternationalDelivery( Item item ) {
        super( item );
    }

    @Override
    public int getPrice() {
        return 5  + super.getPrice();
    }
}
```

```java
public class GiftPacking extends ItemExtras {

    public GiftPacking( Item item ) {
        super( item );
    }

    @Override
    public int getPrice() {
        return 15 + super.getPrice();
    }
}
```

```
public static void main( String[] args ) {

    Item book = new Book( 10 );
    book.getPrice(); //10

    Item international = new InternationalDelivery( book );
    international.getPrice(); //15

}
```

```java
public static void main( String[] args ) {

    Item book = new Book( 10 );
    book.getPrice(); //10

    Item internationalGift = new GiftPacking(
                                 new InternationalDelivery( book ) );
    internationalGift.getPrice(); //30

}
```



```
public static void main( String[] args ) {

    Item book = new Book( 10 );
    book.getPrice(); //10

    Item internationalGiftWithTaxes = new InternacionalTaxes(
                                      new GiftPacking(
                                      new InternationalDelivery( book );
    internationalGiftWithTaxes.getPrice(); //80
  }
}
```

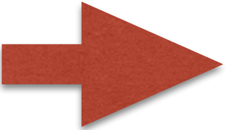
Decorator

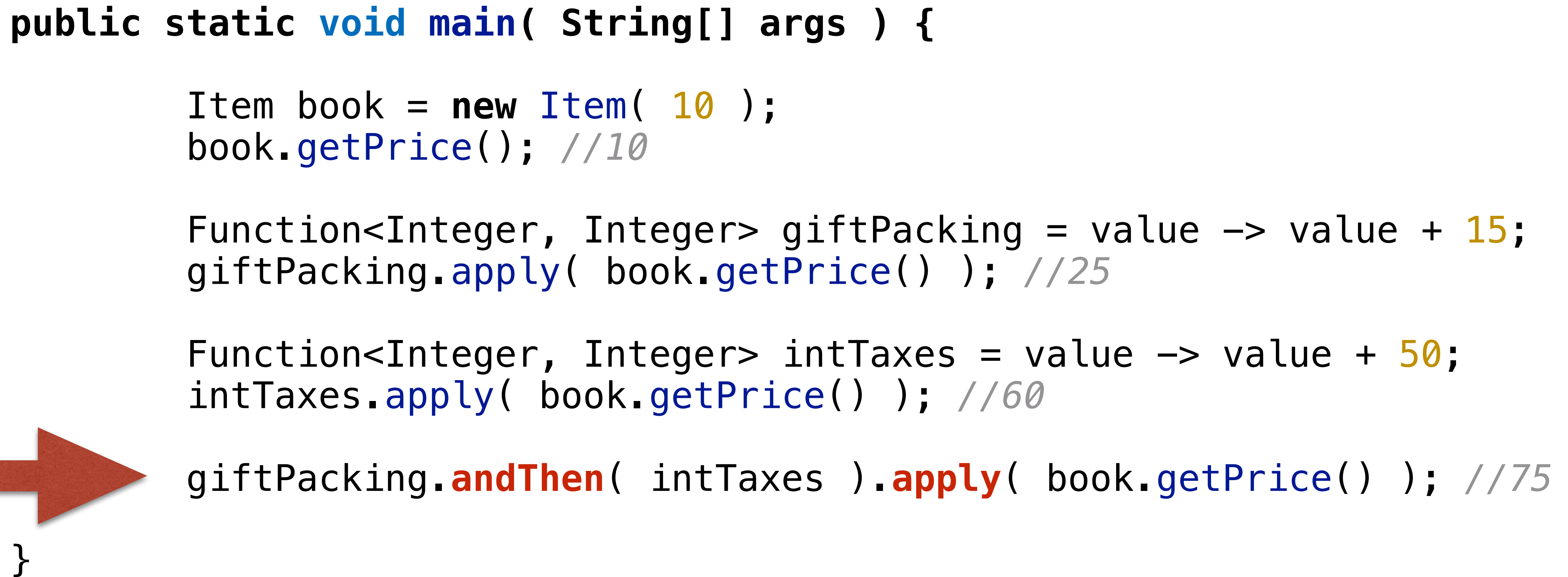
"Dinamicamente, agregar responsabilidades adicionais a objetos. Os Decorators fornecem uma alternativa flexível ao uso de subclasses para extensão de funcionalidades."
GAMMA, Erich et al.

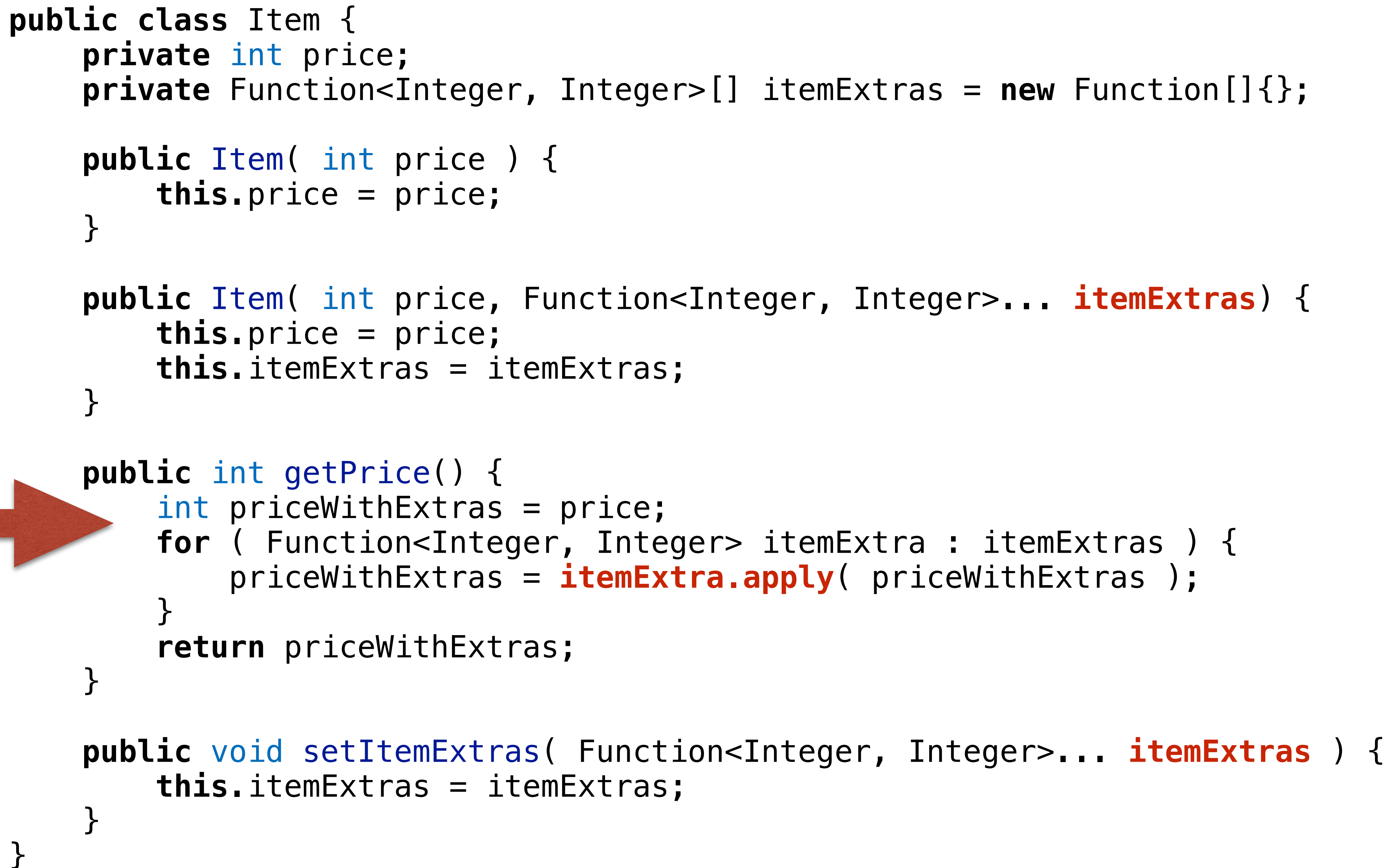
```
new BufferedReader(new FileReader(new File("some.file")));
```

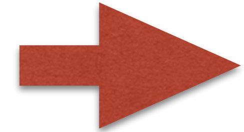
```java
public static void main( String[] args ) {

        Item book = new Item( 10 );
        book.getPrice(); //10

        Function<Integer, Integer> giftPacking = value -> value + 15;
        giftPacking.apply( book.getPrice() ); //25
}
```

```java
public static void main( String[] args ) {

        Item book = new Item( 10 );
        book.getPrice(); //10

        Function<Integer, Integer> giftPacking = value -> value + 15;
        giftPacking.apply( book.getPrice() ); //25

        Function<Integer, Integer> intTaxes = value -> value + 50;
        intTaxes.apply( book.getPrice() ); //60

}
```

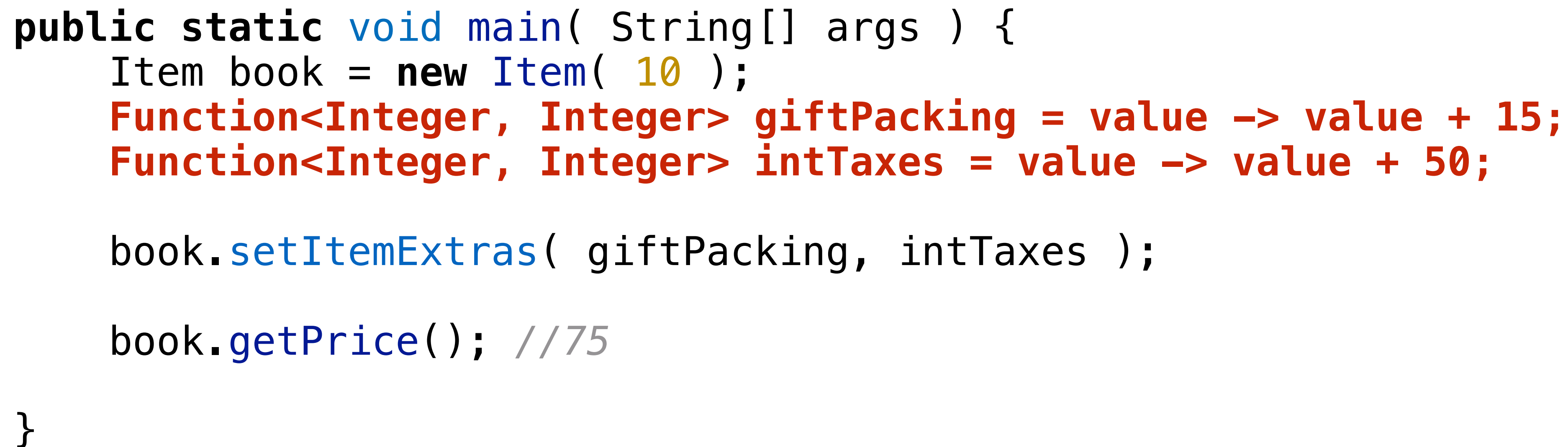



public static void main(String[] args) {
Item book = new Item(10);
book.getPrice(); //10
Function<Integer, Integer> giftPacking = value -> value + 15;
giftPacking.apply(book.getPrice()); //25
Function<Integer, Integer> intTaxes = value -> value + 50;
intTaxes.apply(book.getPrice()); //60
giftPacking.andThen(intTaxes).apply(book.getPrice()); //75
}


public class Item {
private int price;
private Function<Integer, Integer>[] itemExtras = new Function[]{};
public Item(int price) {
this.price = price;
}
public Item(int price, Function<Integer, Integer>... itemExtras) {
this.price = price;
this.itemExtras = itemExtras;
}
public int getPrice() {
int priceWithExtras = price;
for (Function<Integer, Integer> itemExtra : itemExtras) {
priceWithExtras = itemExtra.apply(priceWithExtras);
}
return priceWithExtras;
}
public void setItemExtras(Function<Integer, Integer>... itemExtras) {
this.itemExtras = itemExtras;
}
}



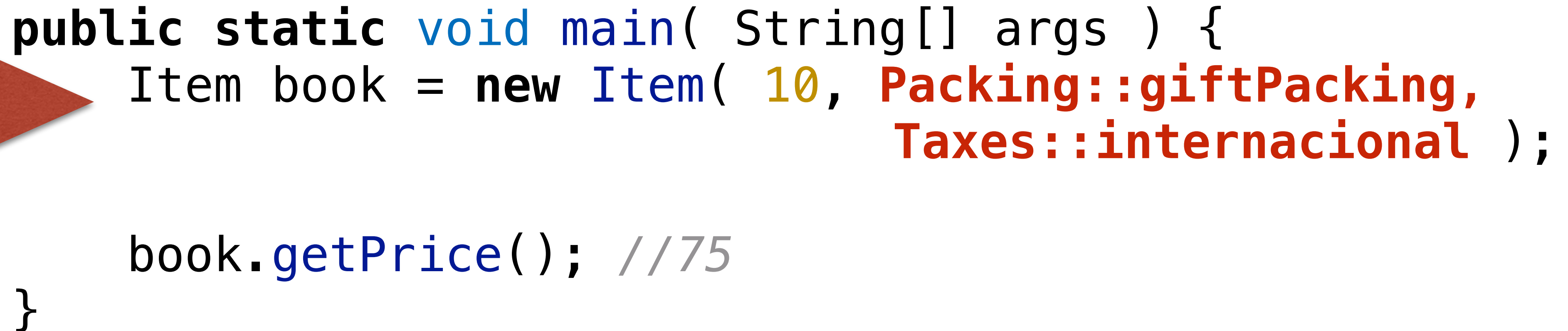
```
public static void main( String[] args ) {
    Item book = new Item( 10 );
    Function<Integer, Integer> giftPacking = value -> value + 15;
    Function<Integer, Integer> intTaxes = value -> value + 50;

    book.setItemExtras( giftPacking, intTaxes );

    book.getPrice(); //75

}
```

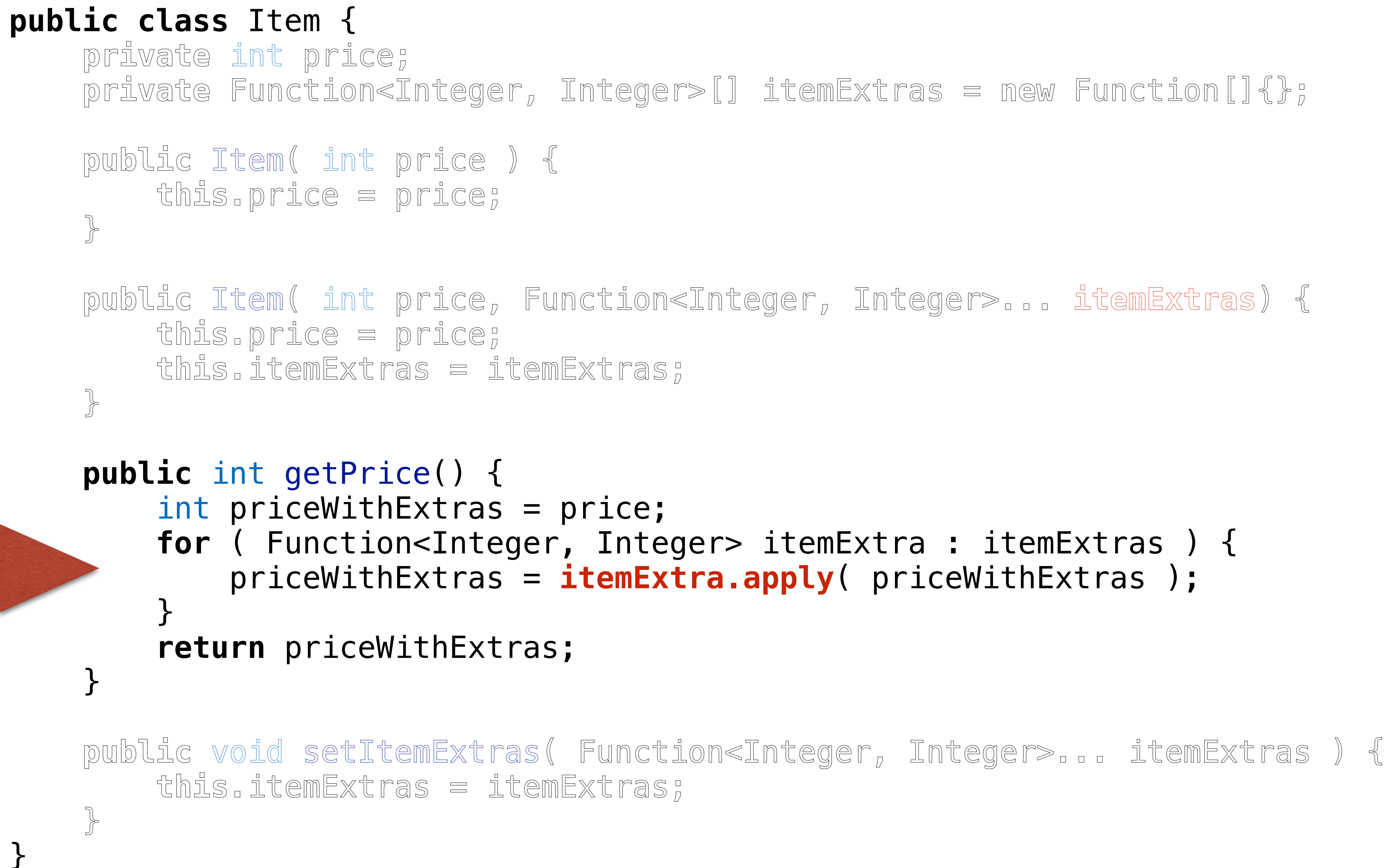


```java
public static void main( String[] args ) {
    Item book = new Item( 10 );
    Function<Integer, Integer> giftPacking = value -> value + 15;
    Function<Integer, Integer> intTaxes = value -> value + 50;

    book.setItemExtras( giftPacking, intTaxes );

    book.getPrice(); //75

}
```

```java
public class Packing {

    public static Integer giftPacking( Integer value ) {
        return value + 15;
    }
//other packing options here
}
```

```java
public class Taxes {

    public static Integer internacional( Integer value ) {
        return value + 50;
    }
//other taxes here
}
```


public static void main(String[] args) {
Item book = new Item(10, Packing::giftPacking,
Taxes::internacional);
book.getPrice(); //75
}

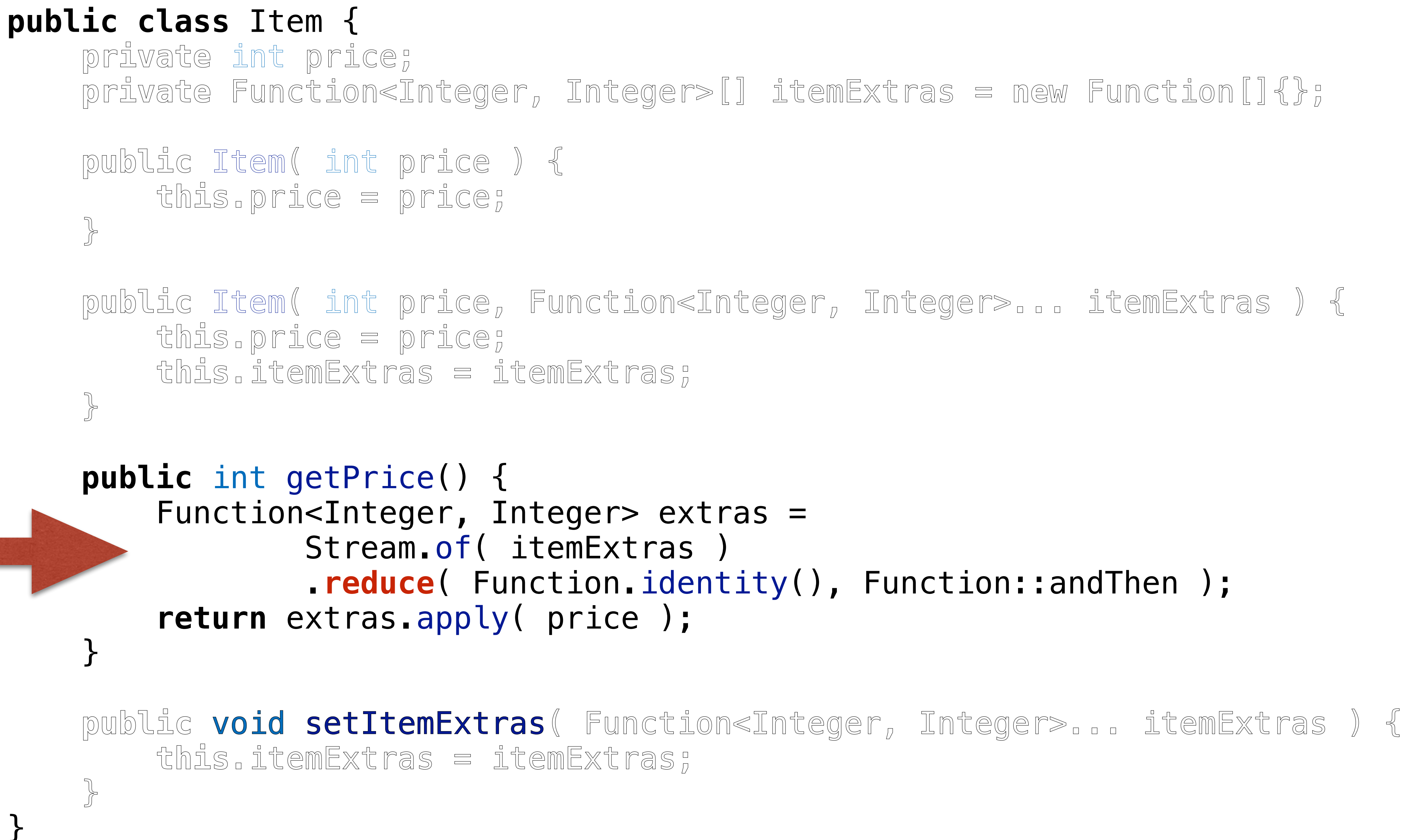

public class Item {
    private int price;
    private Function<Integer, Integer>[] itemExtras = new Function[]{};

    public Item(int price) {
        this.price = price;
    }

    public Item(int price, Function<Integer, Integer>... itemExtras) {
        this.price = price;
        this.itemExtras = itemExtras;
    }

    public int getPrice() {
        int priceWithExtras = price;
        for (Function<Integer, Integer> itemExtra : itemExtras) {
            priceWithExtras = itemExtra.apply(priceWithExtras);
        }
        return priceWithExtras;
    }

    public void setItemExtras(Function<Integer, Integer>... itemExtras) {
        this.itemExtras = itemExtras;
    }
}

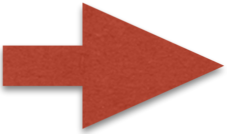


```
public class Item {
    private int price;
    private Function<Integer, Integer>[] itemExtras = new Function[]{};

    public Item( int price ) {
        this.price = price;
    }

    public Item( int price, Function<Integer, Integer>... itemExtras ) {
        this.price = price;
        this.itemExtras = itemExtras;
    }

    public int getPrice() {
        Function<Integer, Integer> extras =
                Stream.of( itemExtras )
                .reduce( Function.identity(), Function::andThen );
        return extras.apply( price );
    }

    public void setItemExtras( Function<Integer, Integer>... itemExtras ) {
        this.itemExtras = itemExtras;
    }
}
```

Recursões

Fibonacci

$$f(n) = \begin{cases} 0 & if \quad n = 0 \\ 1 & if \quad n = 1 \\ F(n-1) + F(n-2) & if \quad n > 1 \end{cases}$$



```java
public static Long fib( int n ) {
     if ( n < 2 ) {
          return new Long( n );
     } else {
          return fib( n - 1 ) + fib( n - 2 );
     }
 }
```

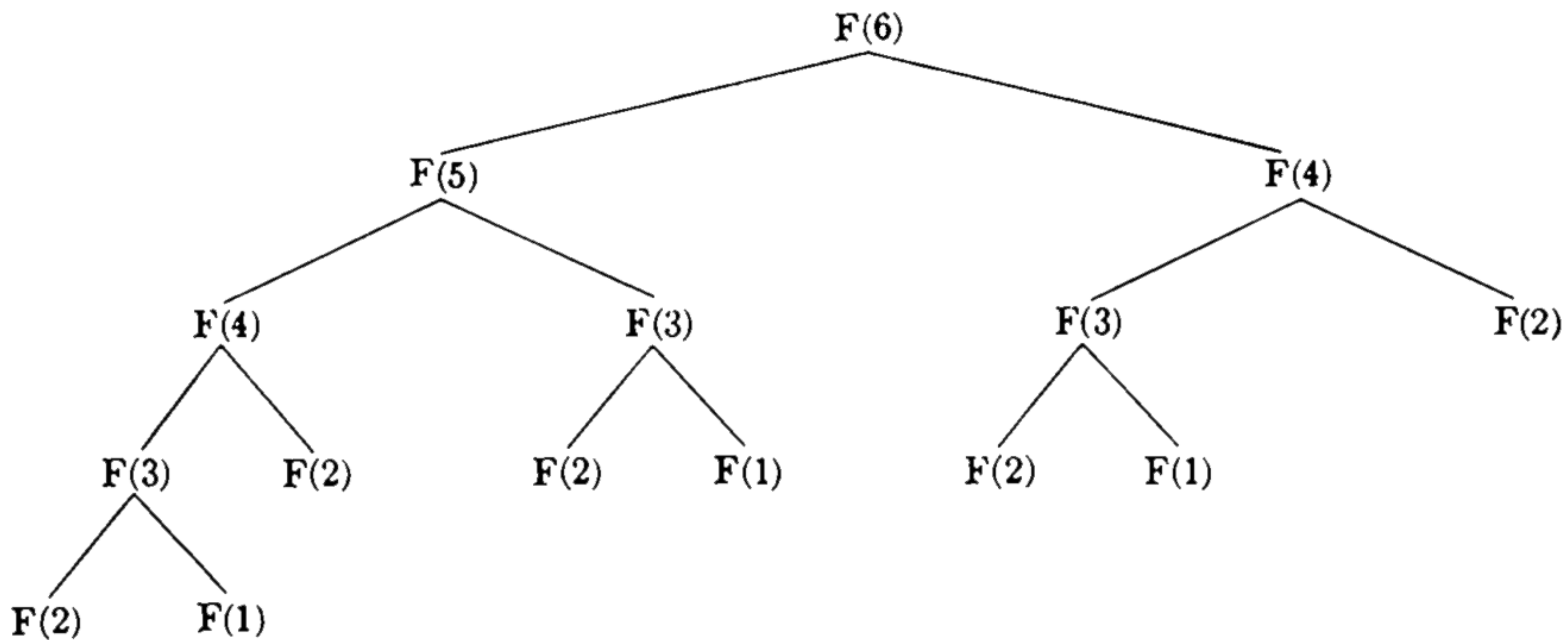


FIG. 1

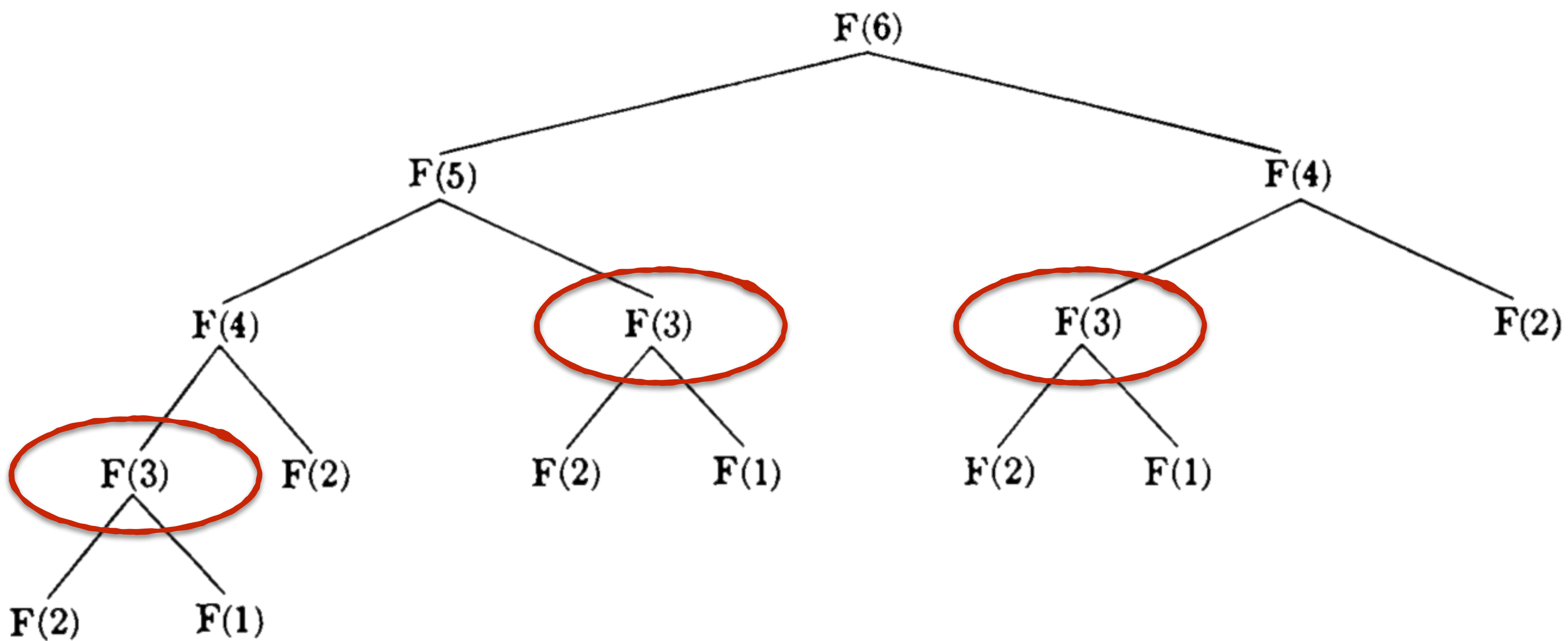


FIG. 1

Memoization

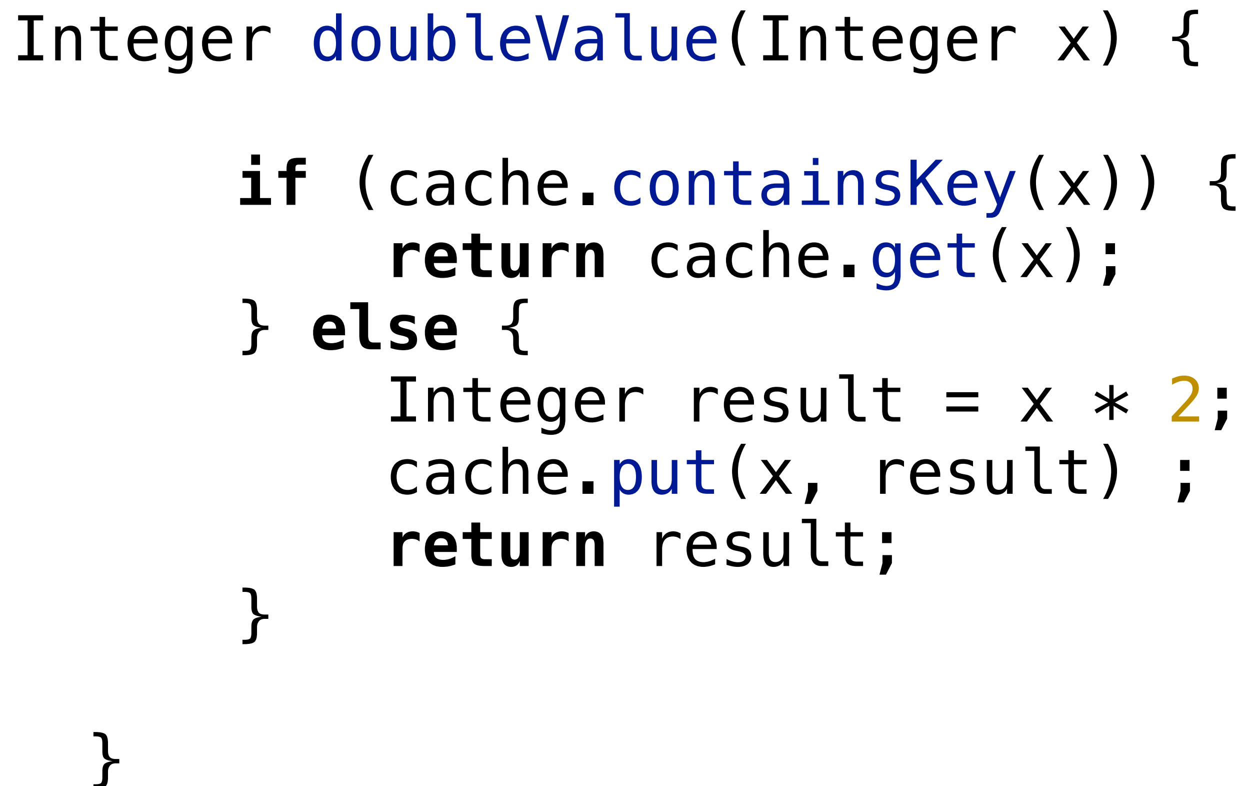
Pure Functions

In computer programming, a function may be described as a pure function if both these statements about the function hold:

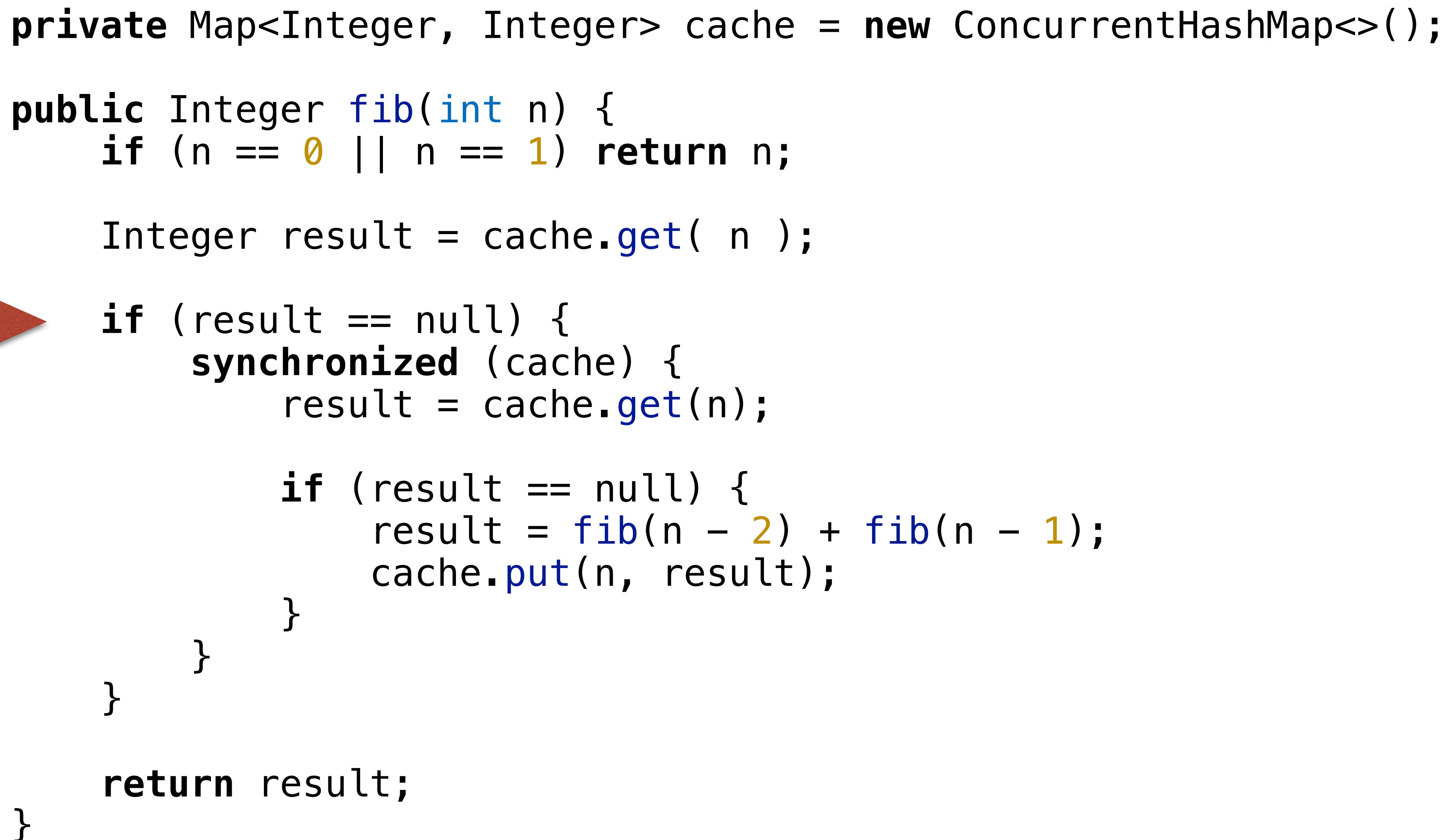
1-) The function **always evaluates the same result value given the same argument value(s).** The function result value cannot depend on any hidden information or state that may change as program execution proceeds or between different executions of the program, nor can it depend on any external input from I/O devices (usually—see below.

2-) **Evaluation of the result does not cause any semantically observable side effect** or output, such as mutation of mutable objects or output to I/O devices (usually—see below)

Manual



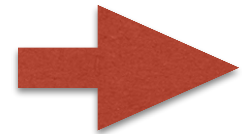
Integer doubleValue(Integer x) {
return x * 2;
}
Integer doubleValue(Integer x) {
if (cache.containsKey(x)) {
return cache.get(x);
} else {
Integer result = x * 2;
cache.put(x, result) ;
return result;
}
}

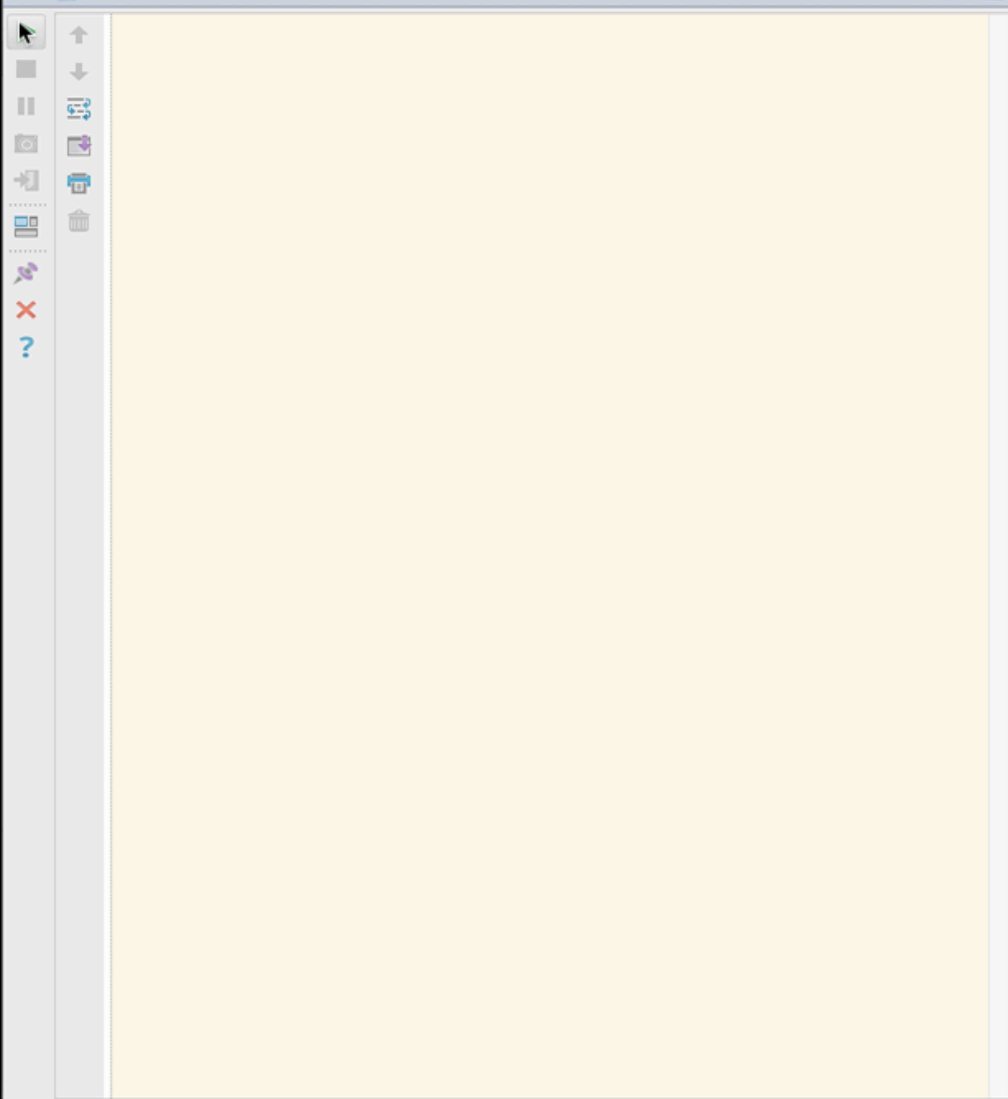


```java
private Map<Integer, Integer> cache = new ConcurrentHashMap<>();

public Integer fib(int n) {
    if (n == 0 || n == 1) return n;

    Integer result = cache.get( n );

    if (result == null) {
        synchronized (cache) {
            result = cache.get(n);

            if (result == null) {
                result = fib(n - 2) + fib(n - 1);
                cache.put(n, result);
            }
        }
    }

    return result;
}
```

Java + FP to the rescue

```java
private static Map<Integer, Long> memo = new HashMap<>();

static {
    memo.put( 0, 0L ); //fibonacci(0)
    memo.put( 1, 1L ); //fibonacci(1)
}

public static long fibonacci( int x ) {
    return memo.
        computeIfAbsent(
            x, n -> fibonacci( n - 1 ) + fibonacci( n - 2 ) );
}
```




IntelliJ IDEA File Edit View Navigate Code Analyze Refactor Build Run Tools VCS Window Help
100% Sun 12:24 PM Eder Ignatowicz
Run
Run Fibonacci
Debug - MemoizedFibonacci
Console

Currying

$$f(x,y) = y/x$$

$$f(2,3)$$

$$f(x,y) = y/x$$

```
f(2, y) = y / 2

g(y) = f(2,y) = y/2
```

$$g(y) = f(2,y) = y/2$$
$$g(3) = f(2,3) = 3/2$$

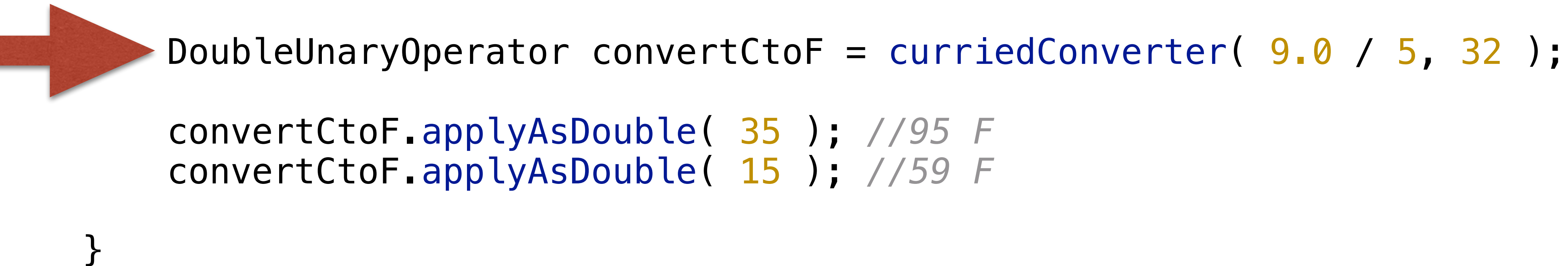
```
CtoF(x) = x * 9/5 + 32
```

```
static double converter( double x, double f, double b ) {
    return x * f + b;
}

public static void main( String[] args ) {

    Double celsius = 15.0;
    Double fahrenheit = converter( celsius, 9.0 / 5, 32 ); //59 F
}
```

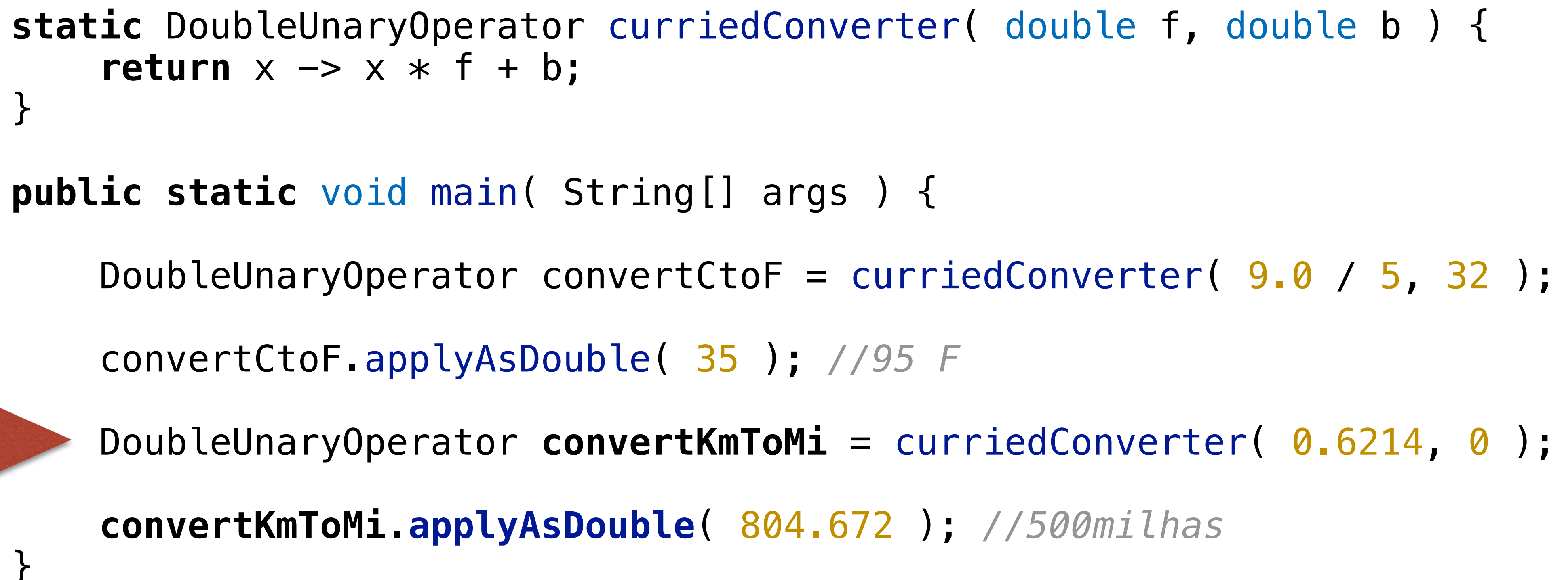
```java
static double converter( double x, double f, double b ) {
    return x * f + b;
}
```

```java
static DoubleUnaryOperator curriedConverter( double f, double b ) {
    return x -> x * f + b;
}
```

```
static DoubleUnaryOperator curriedConverter( double f, double b ) {
     return x -> x * f + b;
 }

 public static void main( String[] args ) {
```



```
     DoubleUnaryOperator convertCtoF = curriedConverter( 9.0 / 5, 32 );

     convertCtoF.applyAsDouble( 35 ); //95 F
     convertCtoF.applyAsDouble( 15 ); //59 F

 }
```



```
static DoubleUnaryOperator curriedConverter( double f, double b ) {
    return x -> x * f + b;
}

public static void main( String[] args ) {

    DoubleUnaryOperator convertCtoF = curriedConverter( 9.0 / 5, 32 );

    convertCtoF.applyAsDouble( 35 ); //95 F

    DoubleUnaryOperator convertKmToMi = curriedConverter( 0.6214, 0 );

    convertKmToMi.applyAsDouble( 804.672 ); //500milhas
}
```

```java
DoubleUnaryOperator convertBRLtoUSD = curriedConverter( 0.27, 0 );

double usd = convertBRLtoUSD.applyAsDouble( 100 );//27 USD

DoubleUnaryOperator convertUSDtoEUR = curriedConverter( 0.89, 0 );
convertUSDtoEUR.applyAsDouble( usd ); //24.03 EUR

convertBRLtoUSD.andThen( convertUSDtoEUR ).applyAsDouble( 100 );

            //24.03 EUR
```

E agora?

Programar funcional em Java é uma mudança de paradigma

Java é multi-paradigma

Imperativo, OO e Funcional

Escolha o melhor deles para o seu problema

Programação Funcional trouxe uma nova vida para o Java

DIVIRTA-SE!

Obrigado!!!

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