Refactoring to Java 8 Streams and Lambdas 2.0

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Javaspecialists.eu
java training

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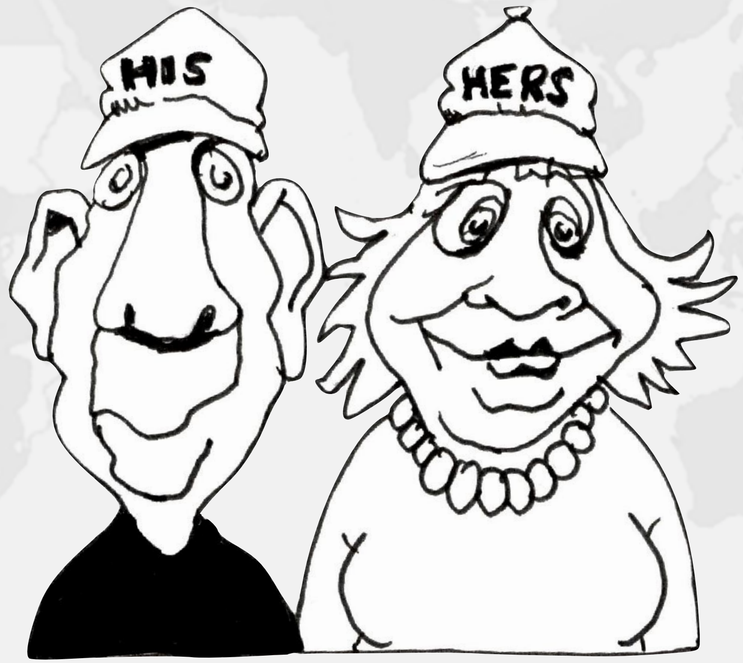
Introduction

Warm Welcome - Course Author

- **Dr Heinz Kabutz**
  - **Born in Cape Town, now lives on Crete**
  - **Created The Java Specialists' Newsletter**
    - **www.javaspecialists.eu**
  - **One of the first Java Champions**
    - **www.javachampions.org**

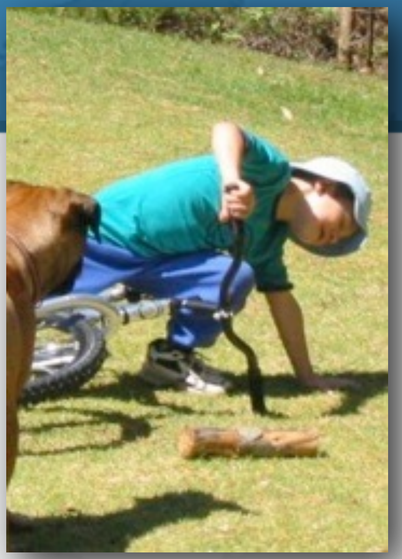
Comfort and Learning

- **We need**
  - **oxygen**
  - **short breaks every 45 minutes**
  - **physical exercise after class**
    - **Run, walk, gym, cycle, etc.**



Questions

- **Please please please please ask questions!**
  - **For self-study, please leave comment in sections**
- **Interrupt me at any time**
  - **Questions that are off-topic might be delayed until later**
  - **If so, please write down question and we can look at it during exercise time**
- **There are some stupid questions**
  - **They are the ones we did not ask**
  - **Once we have asked them, they are not stupid anymore**
- **The more we ask, the more everyone learns**



Exercises

- We learn cycling by falling
  - Listening to lectures is not enough
- Exercises help us to internalize refactoring
- Please make sure you have at least Java 8
- IntelliJ IDEA 2020.2 or later
- Get project using git
  - Will send you URL and credentials now

Refactoring

How to do it

Refactoring

- **Pioneered by Martin Fowler**
  - **Based on research by William Opdyke**
- **What it is**
  - **Improving the design of existing code**
    - **Without adding new functionality**
- **Unit testing**
  - **Bad refactorings often introduce bugs**
- **IntelliJ**
  - **Analyze -> Inspect Code great, even in Community Edition**

Inspecting Code with IntelliJ IDEA

Quick demo

Java Language Changes

Java Language Changes

- **Java 1.1**
  - **Inner classes and anonymous inner classes**
    - **Also called anonymous types**
  - **No more "private protected"**
- **Java 2**
  - **java.util collections and maps**
- **Java 3**
  - **Not much**
- **Java 4**
  - **assert keyword added**

Java Language Changes

- **Java 5**
  - **Generics**
  - **java.util.concurrent thread-safe classes**
  - **Enums**
  - **Autoboxing**
  - **Enhanced 'for' loop**
  - **StringBuilder**
- **Java 6**
  - **Not much**

Java Language Changes

- **Java 7**
  - **Diamond generics operator <>**
  - **Objects.equals()**
  - **Multi-catch in try-catch**
  - **try-with-resource**
  - **Compare for numbers**
  - **Switching on String**

Java Language Changes

- **Java 8**
  - **Default and static interface methods**
  - **Lambdas**
  - **Method references**
  - **Compound Map methods**
    - **putIfAbsent(), computeIfAbsent(), merge(), etc.**
  - **Collection.removeIf**
  - **Optional**
  - **Streams**
    - **Primitive vs Object streams**
    - **allMatch(), map(), filter(), findFirst(), collect(), etc.**
    - **Spliterators**

Java Language Changes

- **Java 9**
  - **Java Platform Module System (JPMS)**
  - **Diamond operator for anonymous types**
  - **List.of(), Set.of(), Map.of()**
- **Java 10**
  - **Local variable can be omitted (**var**)**
- **Java 11**
  - **Not much**
- **Java 14**
  - **Enhanced switch**

Java Language Changes

- **Java 14 Preview**
  - **Records**
  - **Pattern variables**
  - **Text blocks**
- **Java 15**
  - **Text blocks**

1. Default Methods in Interfaces

1. Default Methods in Interfaces

- **ConcurrentMap vs Map in Java 5**
- **List.sort() vs Collections.sort()**
  - **AuthHelper.loadAuthenticators_internal()**

```
Collections.sort(authenticators, new AuthenticationComparator());
```

```
authenticators.sort(new AuthenticationComparator());
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **Look in task1_defaultMethodsInInterfaces()**

```
AuthHelper.loadAuthenticators_internal()
BillingAccountWorker.makePartyBillingAccountList()
ContentJsonEvents.getContentAssocs()
EntityUtil.orderBy()
OrderMapList.exec()
ProductDisplayWorker.productOrderByMap()
ShoppingCart.getLineListOrderedByBasePrice()
UtilMisc.sortMaps()
```

Static Methods in Interfaces

Static Methods in Interfaces

- **ContentJsonEvents.getContentAssocs()**

```
nodes.sort(new Comparator<Map<String, Object>>() {
  public int compare(Map<String, Object> node1, Map<String, Object> node2) {
    Map<String, Object> data1 = UtilGenerics.cast(node1.get("data"));
    Map<String, Object> data2 = UtilGenerics.cast(node2.get("data"));
    if (data1 == null || data2 == null) return 0;
    String title1 = (String) data1.get("title");
    String title2 = (String) data2.get("title");
    if (title1 == null || title2 == null) return 0;
    return title1.toLowerCase(Locale.getDefault())
      .compareTo(title2.toLowerCase(Locale.getDefault()));
  }
});
```

Comparator interface static methods

- **Comparator.comparing(Function<T, U>)**
- **Comparator.nullsFirst(Comparator)**

Functional Interfaces

Predicate, Consumer, Function, Supplier

Functional Interfaces

- Interface with a single abstract method
  - e.g. Runnable
- java.util.function has 43 "functional interfaces"
- But actually only 4
  - Predicate (5)
  - Consumer (8)
  - Function (25)
  - Supplier (5)
- Interfaces for int, long, double and objects
  - e.g. IntPredicate, LongPredicate, DoublePredicate, Predicate

Static Methods in Interfaces

- **Comparator with a key extractor Function**

```
nodes.sort(
  Comparator.comparing(new Function<Map<String, Object>, String>() {
    public String apply(Map<String, Object> node) {
      Map<String, Object> data = (Map<String, Object>) node.get("data");
      if (data == null) return null;
      String title = (String) data.get("title");
      if (title == null) return null;
      return title.toLowerCase(Locale.getDefault());
    }
  })
);
```

Static Methods in Interfaces

- **With the nullsFirst comparator**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing(new Function<Map<String, Object>, String>() {
      public String apply(Map<String, Object> node) {
        Map<String, Object> data = (Map<String, Object>) node.get("data");
        if (data == null) return null;
        String title = (String) data.get("title");
        if (title == null) return null;
        return title.toLowerCase(Locale.getDefault());
      }
    })
  )
);
```

2. Lambdas

2. Lambdas

- **Tedious to type anonymous types**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing(new Function<Map<String, Object>, String>() {
      public String apply(Map<String, Object> node) {
        Map<String, Object> data = (Map<String, Object>) node.get("data");
        if (data == null) return null;
        String title = (String) data.get("title");
        if (title == null) return null;
        return title.toLowerCase(Locale.getDefault());
      }
    })
  )
);
```

Lambdas

- **The compiler can deduce all this**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing(new Function<Map<String, Object>, String>() {
      public String apply(Map<String, Object> node) {
        Map<String, Object> data = (Map<String, Object>) node.get("data");
        if (data == null) return null;
        String title = (String) data.get("title");
        if (title == null) return null;
        return title.toLowerCase(Locale.getDefault());
      }
    })
  )
);
```

Lambdas

- **Replaced with lambda using –>**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing((Map<String, Object> node) -> {
      Map<String, Object> data = (Map<String, Object>) node.get("data");
      if (data == null) return null;
      String title = (String) data.get("title");
      if (title == null) return null;
      return title.toLowerCase(Locale.getDefault());
    })
  )
);
```

Lambdas

- **Method parameter can be omitted**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing((Map<String, Object> node) -> {
      Map<String, Object> data = (Map<String, Object>) node.get("data");
      if (data == null) return null;
      String title = (String) data.get("title");
      if (title == null) return null;
      return title.toLowerCase(Locale.getDefault());
    })
  )
);
```

Lambdas

- **Less clutter**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing((node) -> {
      Map<String, Object> data = (Map<String, Object>) node.get("data");
      if (data == null) return null;
      String title = (String) data.get("title");
      if (title == null) return null;
      return title.toLowerCase(Locale.getDefault());
    })
  )
);
```

Lambdas

- **Single parameter does not need brackets**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing((node) -> {
      Map<String, Object> data = (Map<String, Object>) node.get("data");
      if (data == null) return null;
      String title = (String) data.get("title");
      if (title == null) return null;
      return title.toLowerCase(Locale.getDefault());
    })
  )
);
```

Lambdas

- **That's better!**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing(node -> {
      Map<String, Object> data = (Map<String, Object>) node.get("data");
      if (data == null) return null;
      String title = (String) data.get("title");
      if (title == null) return null;
      return title.toLowerCase(Locale.getDefault());
    })
  )
);
```

Let's extract the body as a method

- **That's better!**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing(node -> { return extractTitle(node); })
  )
);
private static String extractTitle(Map<String, Object> node) {
  Map<String, Object> data = (Map<String, Object>) node.get("data");
  if (data == null) return null;
  String title = (String) data.get("title");
  if (title == null) return null;
  return title.toLowerCase(Locale.getDefault());
}
```

Statement vs Expression Lambda

- **Can also get rid of return**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing(node -> { return extractTitle(node); })
  )
);
```

Statement vs Expression Lambda

- **We can breathe again**

```
nodes.sort(
  Comparator.nullsFirst(
    Comparator.comparing(node -> extractTitle(node))
  )
);
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task2_replaceAnonymousTypeWithLambda()**

```
DataResourceWorker.getDataResourceContentUploadPath()
EntityFunction.LENGTH.FETCHER
EntityFunction.TRIM.FETCHER
EntityFunction.UPPER.FETCHER
EntityFunction.LOWER.FETCHER
ModelWidgetCondition.DefaultConditionFactory.TRUE
ModelWidgetCondition.DefaultConditionFactory.FALSE
SSLUtil.getHostnameVerifier()
AuthHelper.getContextClassLoader()
ContentJsonEvents.getContentAssocs()
DelegatorEcaHandler.setDelegator()
```

3. Method References

3. Method References

- **Lambdas often follow the same pattern**

```
x -> x.f()
x -> f(x)
x -> new A(x)
x -> B.f(x)
```

- **Each of these can be changed to a *method reference***

```
x -> x.f()      =>  A::f
x -> f(x)       =>  this::f
x -> new A(x)   =>  A::new
x -> B.f(x)     =>  B::f
```

Examples from ofbiz

```
virtualHost -> host.addAlias(virtualHost)
    => host::addAlias
connectorProp -> prepareConnector(connectorProp)
    => this::prepareConnector

command -> command.getProperties()
    => StartupCommand::getProperties
() -> createEntityEcaHandler()
    => this::createEntityEcaHandler

() -> new HashMap<>()
    => HashMap::new
() -> new LinkedHashSet<>()
    => LinkedHashSet::new

set -> Collections.unmodifiableSet(set)
    => Collections::unmodifiableSet
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task3_replaceLambdaWithMethodReference()**

```
CatalinaContainer.init()
CatalinaContainer.prepareVirtualHost()
CatalinaContainer.prepareTomcatConnectors()
ContainerLoader.filterContainersHavingMatchingLoaders()
EntityDataLoadContainer.init()
EntityUtil.filterByCondition()
GenericDelegator.initEntityEcaHandler()
GenericDelegator.initDistributedCacheClear()
MapContext.entrySet()
MultivaluedMapContextAdapter.entrySet()
ShippingEvents.getGeoIdFromPostalContactMech()
TestRunContainer.init()
UtilMisc.toMap()
```

4. Iterable and Map forEach()

4. Iterable and Map forEach()

- **Both Iterable and Map have a forEach()**
  - **Iterable<E>.forEach(Consumer<E>)**
  - **Map<K, V>.forEach(BiConsumer<K, V>)**

Iterable.forEach()

- **Apply consumer to all entries**
  - **Should not be used for creating a new collection**

```
for (GenericServiceCallback gsc : dispatcher.getCallbacks(model.name)) {
  gsc.receiveEvent(context);
}
```

```
dispatcher.getCallbacks(model.name)
  .forEach(gsc -> gsc.receiveEvent(context));
```

Map.forEach()

- **Instead of iterating over entrySet**

```
for (Entry<? extends K, ? extends V> entry : m.entrySet()) {
  adaptee.putSingle(entry.getKey(), entry.getValue());
}
```

```
m.forEach((k, v) -> adaptee.putSingle(k, v));
```

```
m.forEach(adaptee::putSingle);
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task4_replaceLoopWithForEach()**

Replace with Map.forEach()

```
MultivaluedMapContextAdapter.putAll()
CatalinaContainer.prepareContext()
```

Replace with Iterable.forEach()

```
AbstractEngine.sendCallbacks() x 3
```

  - **Bonus: extract common code into separate method, passing in a Consumer of GenericServiceCallback**

5. removeIf()

5. removeIf()

- **What is wrong with this code?**

```
List<Integer> evens = new ArrayList<>();
for (int i = 0; i < 1_000_000_000; i++) {
  evens.add(i);
}

// oh, we only wanted even numbers?
for (Iterator<Integer> it = evens.iterator(); it.hasNext(); ) {
  Integer i = it.next();
  if (i % 2 == 1) it.remove();
}
```

Quadratic performance

- It will take about a month to finish
  - Each time we remove an item, the items shift left

```
List<Integer> evens = new ArrayList<>();
for (int i = 0; i < 1_000_000_000; i++) {
  evens.add(i);
}

// Linear performance, completing in seconds
evens.removeIf(i -> i % 2 == 1);
```

- Quadratic performance happens with array based lists
  - ArrayList, Vector, CopyOnWriteArrayList

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task5_replaceLoopWithRemoveIf()**

```
ShoppingCart.clearPaymentMethodsById()
ShoppingCart.cleanUpShipGroups()
ShoppingCart.removeFreeShippingProductPromoAction()
ShoppingCart.clearAllPromotionAdjustments()
ShoppingCartItem.removeFeatureAdjustment()
```

6. Map Compound Methods

6. Map Compound Methods

- **getOrDefault(key, defaultValue)**
  - Returns a default value if the key is not in the map
- **putIfAbsent(key, value)**
  - Returns null if we were the first to put with that key; otherwise the old value
- **merge(key, value, remappingFunction)**
  - BiFunction<V, V, V> - merges two values into one
- **computeIfAbsent(key, mappingFunction)**
  - Function<K, V> return a new value for the key
  - Great for maps with values that are collections

Map.getOrDefault()

- **Common coding pattern**

```
if (positions.containsKey(name)) {
  return positions.get(name);
} else {
  return -1;
}
```

- **Can get replaced with**

```
return positions.getOrDefault(name, -1);
```

Map.putIfAbsent()

- **Common coding pattern**

```
if (returnInvoices.get(invoice.getString("invoiceId")) == null) {
  returnInvoices.put(invoice.getString("invoiceId"), invoice);
}
```

- **Can get replaced with**

```
returnInvoices.putIfAbsent(invoice.getString("invoiceId"), invoice);
```

Map.computeIfAbsent

- **How many hash lookups are we doing?**

```
UtilTimer timer = staticTimers.get(timerName);
if (timer == null) {
  timer = new UtilTimer(timerName, false);
  timer.setLog(log);
  staticTimers.putIfAbsent(timerName, timer);
  timer = staticTimers.get(timerName);
}
return timer;
```

```
return staticTimers.computeIfAbsent(timerName, key -> {
  UtilTimer timer = new UtilTimer(key, false);
  timer.setLog(log);
  return timer;
});
```

Map Compound Method Caveats

- **Functions should not change map structure**
  - **In some versions of Java, live lock can happen**
  - **In others, this will cause an exception**
- **Fibonacci "works" in Java 8, exception in Java 9**

```
public class Fibonacci {
  private final Map<Integer, BigInteger> cache = new HashMap<>();
  {
    cache.put(0, BigInteger.ZERO);
    cache.put(1, BigInteger.ONE);
  }

  public BigInteger f(int n) {
    if (n < 0) throw new IllegalArgumentException();
    return cache.computeIfAbsent(n, key -> f(key - 1).add(f(key - 2)));
  }
}
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task6_replaceWithCompoundMapMethods()**

Map.getOrDefault()
AIMRespPositions.getPosition()
CPRespPositions.getPosition()
RequestHandler.renderView()
TaxAuthorityServices.rateProductTaxCalc()
Map.putIfAbsent()
OrderReturnServices.createPaymentApplicationsFromReturnIt
Converters.getConverter()
Map.merge()
ShoppingCartItem.resetPromoRuleUse()
ShoppingCartItem.confirmPromoRuleUse()
OrderReadHelper.getOrderNonReturnedTaxAndShipping()

Map Compound Methods (continued)

Map.computeIfAbsent()

```
UtilTimer.getTimer()
UtilCache.getNextDefaultIndex()
DelegatorFactory.getDelegatorFuture()
GenericDAO.getGenericDAO()
ContentManagementWorker.getParentWebSitePublishPointId()
DatabaseUtil.getColumnInfo()
EntityEcaUtil.readConfig()
FindServices.prepareField()
ModelReader.buildEntity()
ModelReader.rebuildResourceHandlerEntities()
ModelReader.getEntitiesByPackage()
ParametricSearch.makeCategoryFeatureLists()
ShoppingCartServices.loadCartFromQuote()
```

Streams

Object and primitive streams, lazy evaluation, debugging

Streams

- We can create streams from any Iterable
  - list.stream()
  - set.stream()
  - queue.stream()
  - map.entrySet().stream()
- Or from arrays
  - Stream.of(new String[] {"John", "Anton", "Heinz"})
  - IntStream.of(99, 72, 56) or IntStream.range(0, 100)
  - LongStream.of(100, 200, 300)
  - DoubleStream.of(65.3, 114.5, 123.8)

7. Stream.all/any/noneMatch()

7. Stream.all/any/noneMatch()

- **Stream can return boolean**
  - **Takes a Predicate as a parameter**

anyMatch()

- **Any element has to match predicate**
  - **If any matches, we immediately return true**

```
for (ModelField mf : getFieldsUnmodifiable()) {
  if (mf.getEnableAuditLog()) {
    return true;
  }
}
return false;
```

```
return getFieldsUnmodifiable().stream()
  .anyMatch(ModelField::getEnableAuditLog);
```

allMatch()

- **All elements have to match predicate**
  - **If any does not match, we immediately return false**

```
String fullPath = dir.getPath().replace('\\', '/');
boolean hasAllPathStrings = true;
for (String pathString: stringsToFindInPath) {
  if (!fullPath.contains(pathString)) {
    hasAllPathStrings = false;
    break;
  }
}
```

```
String fullPath = dir.getPath().replace('\\', '/');
boolean hasAllPathStrings = stringsToFindInPath.stream()
  .allMatch(fullPath::contains);
```

noneMatch()

- **No elements may match predicate**
  - **If any does match, we immediately return false**

```
for (String element : validOut) {
  if (name.equals(element)) {
    return false;
  }
}
return true;
```

```
return Stream.of(validOut).noneMatch(name::equals);
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task7_replaceWithAllAnyNoneMatch()**

anyMatch()

```
ModelEntity.getHasFieldWithAuditLog()
ProductPromoWorker.hasOrderTotalCondition()
```

allMatch()

```
FileUtil.SearchTextFilesFilter.accept()
ModelEntity.areFields()
EntityJoinOperator.isEmpty()
```

noneMatch()

```
LoginWorker.hasApplicationPermission()
PcChargeApi.checkIn()
PcChargeApi.checkOut()
```

8. Stream.map() and collect()

8. Stream.map() and collect()

- map() converts from one type to another
  - mapToInt() converts object to int for an IntStream
  - mapToLong() converts object to long for a LongStream
  - mapToDouble() converts object to double for a DoubleStream
  - mapToObj() a primitive stream to an object stream
- collect(Collector) converts a stream to a collection
  - Collectors.toSet() converts stream to HashSet
  - Collectors.toList() converts stream to ArrayList

Transforming Loop to map()/collect()

```
List<String> nameList = new ArrayList<>();
for (ModelField field: modelFields) {
  nameList.add(field.getName());
}
return nameList;
```

```
Stream<ModelField> modelFieldsStream = modelFields.stream();
Stream<String> nameStream = modelFieldsStream.map(ModelField::getName);
List<String> nameList = nameStream.collect(Collectors.toList());
return nameList;
```

```
return modelFields.stream() // Stream<ModelField>
  .map(ModelField::getName) // Stream<String>
  .collect(Collectors.toList()); // List<String>
```

Transforming Loop to map()/collect()

```
List<String> nameList = new ArrayList<>();
for (ModelField field: modelFields) {
  nameList.add(field.getName());
}
return nameList;
```

```
Stream<ModelField> modelFieldsStream = modelFields.stream();
Stream<String> nameStream = modelFieldsStream.map(ModelField::getName);
List<String> nameList = nameStream.collect(Collectors.toList());
return nameList;
```

```
return modelFields.stream() // Stream<ModelField>
  .map(ModelField::getName) // Stream<String>
  .collect(Collectors.toList()); // List<String>
```

Transforming Loop to map()/collect()

```
List<String> nameList = new ArrayList<>();
for (ModelField field: modelFields) {
  nameList.add(field.getName());
}
return nameList;
```

```
Stream<ModelField> modelFieldsStream = modelFields.stream();
Stream<String> nameStream = modelFieldsStream.map(ModelField::getName);
List<String> nameList = nameStream.collect(Collectors.toList());
return nameList;
```

```
return modelFields.stream() // Stream<ModelField>
  .map(ModelField::getName) // Stream<String>
  .collect(Collectors.toList()); // List<String>
```

Transforming Loop to map()/collect()

```
List<String> nameList = new ArrayList<>();
for (ModelField field: modelFields) {
  nameList.add(field.getName());
}
return nameList;
```

```
Stream<ModelField> modelFieldsStream = modelFields.stream();
Stream<String> nameStream = modelFieldsStream.map(ModelField::getName);
List<String> nameList = nameStream.collect(Collectors.toList());
return nameList;
```

```
return modelFields.stream() // Stream<ModelField>
  .map(ModelField::getName) // Stream<String>
  .collect(Collectors.toList()); // List<String>
```

Transforming Loop to map()/collect()

```
List<String> nameList = new ArrayList<>();
for (ModelField field: modelFields) {
  nameList.add(field.getName());
}
return nameList;
```

```
Stream<ModelField> modelFieldsStream = modelFields.stream();
Stream<String> nameStream = modelFieldsStream.map(ModelField::getName);
List<String> nameList = nameStream.collect(Collectors.toList());
return nameList;
```

```
return modelFields.stream() // Stream<ModelField>
  .map(ModelField::getName) // Stream<String>
  .collect(Collectors.toList()); // List<String>
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task8_replaceWithMapCollect()**

```
ModelEntity.getFieldNamesFromFieldVector()
ModelReader.getEntityCache()
DelegatorContainer.start()
ContainerConfig.getConfigurationPropsFromXml()
PaymentGatewayServices.capturePaymentsByInvoice()
```

9. Collectors .toCollection()

9. Collectors.toCollection()

- **We can also specify Supplier<Collection>**
  - **toList() makes ArrayList and toSet() makes HashSet**

```
List<V> valuesList = new LinkedList<>();
for (CacheLine<V> line: memoryTable.values()) {
  valuesList.add(line.getValue());
}
return valuesList;
```

```
return memoryTable.values().stream()
  .map(CacheLine::getValue)
  .collect(Collectors.toCollection(LinkedList::new));
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task9_replaceWithMapCollectToCollection()**

```
EntityJoinOperator.freeze()
UtilCache.values()
UtilDateTime.TimeZoneHolder.getTimeZones()
```

10. Stream.filter()

10. Stream.filter()

- **Stream.filter() predicate of what to keep**

```
List<EntityCondition> entityConditionList =
  new ArrayList<>();
for (Condition cond: conditionList) {
  EntityCondition econd = cond.createCondition(
    context, modelEntity, modelFieldTypeReader);
  if (econd != null) {
    entityConditionList.add(econd);
  }
}
```

```
List<EntityCondition> entityConditionList = conditionList.stream()
  .map(cond -> cond.createCondition(
    context, modelEntity, modelFieldTypeReader))
  .filter(Objects::nonNull)
  .collect(Collectors.toList());
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task10_replaceWithMapFilterCollect()**

```
EntityDataLoader.getUrlByComponentList()
EntityFinderUtil.ConditionList.createCondition()
ContainerConfig.Configuration.getPropertiesWithValue()
```

11. Collectors .toMap()

11. Collectors.toMap()

- **We can also collect to a Map**

```
Map<String, ModelMenu> modelMenuMap = new HashMap<>();
for (Element menuElement: UtilXml.childElementList(rootElement, "menu")){
  ModelMenu modelMenu = new ModelMenu(menuElement, menuLocation, visualTheme);
  modelMenuMap.put(modelMenu.getName(), modelMenu);
}
```

```
 modelMenuMap = UtilXml.childElementList(rootElement, "menu").stream()
   .map(menuElement -> new ModelMenu(menuElement, menuLocation, visualTheme))
   .collect(Collectors.toMap(
     ModelWidget::getName, // how key is generated
     modelMenu -> modelMenu, // how value is generated
     (a, b) -> b)); // how duplicates are resolved
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task11_replaceWithStreamCollectToMap()**

```
CheckOutHelper.makeBillingAccountMap()
ComponentConfig.ComponentConfig()
MenuFactory.readMenuDocument()
ModelScreenWidget.DecoratorScreen.DecoratorScreen()
```

12. Stream .reduce()

12. Stream.reduce()

- **Can merge all values into one with reduce()**

```
BigDecimal totalAmount = BigDecimal.ZERO;
for (Map.Entry<String, String> rowEntry : amountMap.entrySet()) {
  if (UtilValidate.isNotEmpty(rowEntry.getValue())) {
   totalAmount = totalAmount.add(new BigDecimal(rowEntry.getValue()));
  }
}
return totalAmount;
```

```
return amountPercentageMap.entrySet().stream()
  .map(Map.Entry::getValue)
  .filter(UtilValidate::isNotEmpty)
  .map(BigDecimal::new)
  .reduce(BigDecimal.ZERO, BigDecimal::add);
```

12. Stream.reduce()

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  .map(BigDecimal::new)
  .reduce(BigDecimal.ZERO, BigDecimal::add);
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task12_replaceWithReduce()**

```
GeneralLedgerServices.calculateCostCenterTotal()
InvoiceServices.updatePaymentApplicationDefBd()
OrderReadHelper.calcOrderPromoAdjustmentsBd()
```

13. Stream .flatMap()

13. Stream.flatMap()

- **flatMap() extracts items from nested streams**

```
List<ClasspathInfo> classpaths = new ArrayList<>();
for (ComponentConfig cc : getAllComponents()) {
  if (componentName == null
      || componentName.equals(cc.getComponentName())) {
    classpaths.addAll(cc.getClasspathInfos());
  }
}
return classpaths;
```

```
return getAllComponents().stream()
  .filter(cc -> componentName == null
           || componentName.equals(cc.getComponentName()))
  .map(ComponentConfig::getClasspathInfos)
  .flatMap(Collection::stream)
  .collect(Collectors.toList());
```

13. Stream.flatMap()

- **flatMap() extracts items from nested streams**

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  }
}
return classpaths;
```

```
return getAllComponents().stream()
  .filter(cc -> componentName == null
           || componentName.equals(cc.getComponentName()))
  .map(ComponentConfig::getClasspathInfos)
  .flatMap(Collection::stream)
  .collect(Collectors.toList());
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task13_replaceWithFlatMap()**

```
ComponentConfig.getAllClasspathInfos()
ComponentConfig.getAllConfigurations()
ComponentConfig.getAllKeystoreInfos()
ComponentConfig.getAllTestSuiteInfos()
ComponentConfig.getAllWebappResourceInfos()
```

14. Optional, findFirst(), findAny()

14. Optional, findFirst(), findAny()

- A method might not have a good return value
  - For example, findFirst() on an empty stream?
- Most important methods on Optional are
  - ifPresent(Consumer)
  - map(Function)
  - orElse(other), orElseGet(otherSupplier), orElseThrow(exceptionSupplier)
  - Java 9: ifPresentOrElse(Consumer, Runnable)
- We create Optional instances with
  - Optional.empty(), Optional.of(val), Optional.ofNullable(val)

Returning an Optional from Stream

- **findFirst(), findAny(), max(), min(), reduce()**

```
for (ModelKeyMap keyMap : keyMaps) {
  if (keyMap.getFieldName().equals(fieldName))
    return keyMap;
}
return null;
```

```
Optional<ModelKeyMap> modelKeyMap = keyMaps.stream()
  .filter(keyMap -> keyMap.getFieldName().equals(fieldName))
  .findFirst();
return modelKeyMap.orElse(null);
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task14_replaceFindFirstOrAny()**

```
ModelRelation.findKeyMap()
ModelRelation.findKeyMapByRelated()
ShoppingCartItem.updatePrice()
OrderReadHelper.getShippableSizes()
```

15. groupingBy(), mapping()

15. groupingBy(), mapping()

- **We can create a Map from a stream**
  - **Function for the key**
  - **Collector for the downstream values**
    - **Can be a collection or a reduced value**

groupingBy(Function)

- **Stream<E> to Map<K, List<V>>**

```
Stream<String> numbers = Stream.of(
  "one", "two", "three", "four",
  "five", "six", "seven", "eight");
Map<Integer, List<String>> map = numbers.collect(
  Collectors.groupingBy(
    String::length // key in the map
  )
);
System.out.println(map.getClass());
map.entrySet().forEach(System.out::println);
```

```
class java.util.HashMap
3=[one, two, six]
4=[four, five]
5=[three, seven, eight]
```

groupingBy() With Collector

- **Stream<E> to Map<K, Collection<V>>**

```
Stream<String> numbers = ...
Map<Integer, Collection<String>> map = numbers.collect(
  Collectors.groupingBy(
    String::length,
    // type of collection for values
    Collectors.toCollection(TreeSet::new)
  )
);
System.out.println(map.getClass());
map.entrySet().forEach(System.out::println);
```

Strings sorted alphabetically

```
class java.util.HashMap
3=[one, six, two]
4=[five, four]
5=[eight, seven, three]
```

groupingBy() With Supplier<Map>

- **Stream<E> to TreeMap<K, TreeSet<V>>**

```
Stream<String> numbers = ...
TreeMap<Integer, TreeSet<String>> map = numbers.collect(
  Collectors.groupingBy(
    String::length,
    TreeMap::new, // type of map
    Collectors.toCollection(TreeSet::new)
  )
);
System.out.println(map.getClass());
map.entrySet().forEach(System.out::println);
```

Map is now a TreeMap

```
class java.util.TreeMap
3=[one, six, two]
4=[five, four]
5=[eight, seven, three]
```

groupingBy() With mapping()

- **Stream<E> to Map<K, HashSet<V>>**

```
Stream<String> numbers = ...
Map<Integer, HashSet<String>> map = numbers.collect(
  Collectors.groupingBy(
    String::length,
    Collectors.mapping(
      String::toUpperCase, // value in the collection
      Collectors.toCollection(HashSet::new)
    )
  )
);
System.out.println(map.getClass());
map.entrySet().forEach(System.out::println);
```

Strings are upper case

```
class java.util.HashMap
3=[SIX, ONE, TWO]
4=[FIVE, FOUR]
5=[EIGHT, THREE, SEVEN]
```

groupingBy() With counting()

- **Stream<E> to Map<K, Long>**

```
Stream<String> numbers = ...
Map<Integer, Long> map = numbers.collect(
  Collectors.groupingBy(
    String::length, // key in the map
    Collectors.counting() // count how many of each key
  )
);
System.out.println(map.getClass());
map.entrySet().forEach(System.out::println);
```

```
class java.util.HashMap
3=3
4=2
5=3
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task15_replaceWithCollectGroupingByMapping()**

`ModelReader.rebuildResourceHandlerEntities()`

16. Checked Exceptions

16. Checked Exceptions

- **Streams do not support checked exceptions**
  - **The Java language architects were aware of this**
    - **But underestimated the pain level**

"Sneaky Throw"

- **Uses vacuous cast trick**

```
class SneakyThrower {
  private SneakyThrower() { }
  static void rethrow(Throwable ex) {
    SneakyThrower.<RuntimeException>uncheckedThrow(ex);
  }
  @SuppressWarnings("unchecked")
  private static <T extends Throwable>
  void uncheckedThrow(Throwable t) throws T {
    if (t != null)
      throw (T) t; // rely on vacuous cast
    else
      throw new Error("Unknown Exception");
  }
}
```

Throwing Functional Interfaces

- **Need to cast to the ThrowingFunction**
  - **Custom Function we added to the project**

```
public interface ThrowingFunction<T, R>
    extends Function<T, R> {
  default R apply(T t) {
    try {
      return applyWithThrow(t);
    } catch (Throwable ex) {
      SneakyThrower.rethrow(ex);
      throw new AssertionError(ex);
    }
  }

  R applyWithThrow(T t) throws Throwable;
}
```

Transforming with Exceptions

- **Casting lambda to a ThrowingFunction**

```
List<GenericValue> currentPayments = new LinkedList<>();
for (GenericValue paymentPref : orderPaymentPrefs) {
  List<GenericValue> payments =
    paymentPref.getRelated("Payment", null, null, false);
  currentPayments.addAll(payments);
}
```

```
List<GenericValue> currentPayments = orderPaymentPrefs.stream()
  .flatMap((ThrowingFunction<GenericValue, Stream<GenericValue>>)
    paymentPref -> paymentPref.getRelated("Payment", null, null, false).stream())
  .collect(Collectors.toCollection(LinkedList::new));
```

Now it's your turn

- **Hyperlinks in RefactoringTasks**
  - **task16_checkedExceptions**

```
EntityUtil.getRelated()
ModelReader.getEntitiesByPackage()
```

Conclusion

Conclusion

- **Where to next?**
  - **Mastering Lambdas - Maurice Naftalin**
  - **Practice, practice, practice**
    - **Use Analyze -> Inspect to find more places to refactor**
  - **Do task99_forTheSuperKeen()**