Advanced Refactorings

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Agenda

- Checklist and example
- Catalog of «bigger» refactorings
- Defensive programming

Checklist and example

Checklist

1. **Run Tests** – Run existing unit tests. In particular, this should be done continuously after each of the following steps.

2. **Apply Coding Conventions** – Follow the coding conventions:
   - Format the source code.
   - If possible, define passing parameters and local variables `final`.
   - Ensure comprehensible constant, variable and method names by the basic refactoring *RENAME*

3. **Break down into individual parts** – If necessary and useful, first break down a more complex section of the program into manageable and useful smaller parts by using (several times) the basic refactoring *EXTRACT METHOD*

Checklist

4. **Write unit tests*** – If requirements are known from the business, the customer or from a requirements document, you should use them to create test cases. Otherwise, write corresponding tests for previously extracted methods:
   - For normal inputs
   - For invalid inputs and for edge or special cases.

5. **Clean Up** – Clean up the source code by:
   - Removing unused variables and unused methods.
   - Removing old, unnecessary or (meanwhile) wrong comments.

*ideally you start writing some pin down tests before you modify unknown code to ensure not to introduce undesired behavioural changes

Checklist

6. **Simplify unit tests** – Reduce complexity
   - Remove duplicated source code, create helper methods if necessary.
   - Simplify conditions.
   - Add explanatory comments if necessary often prefer to consider using descriptive identifiers for attributes and methods.

7. **Perform concrete refactorings unit tests** – improve the source code by using a refactoring from the refactoring catalog that is appropriate for the identified weakness.

The individual steps are not required to be performed slavishly and exactly in this order. It is quite possible to vary the sequence and to omit some steps or possibly even to perform them several times.

Applying checklist

Initial code … **yes I found it like that!**

```
catch (final Fault aF)
{
    final String stSrc = aF.getSource();
    final String stErr = aF.getFaultCode();
    if (stErr != null && stErr.equalsIgnoreCase("FileNotFound"))
    {
        stErrorMsg = aF.getFaultString() + ": " + stSrc;
    }
    else
    {
        stErrorMsg = aF.getFaultString() + ": " + stSrc;
    }
}
```

LET‘S DO SOME ANALYSIS …

Applying checklist

Step 2: Apply Coding Conventions: Prefixes and Naming

- Nowadays, prefixes should be used rarely or better avoided altogether – but when reworking an existing part of a program, it is advisable not to turn everything upside down and to follow the existing style to some extent.

```
catch (final Fault fault)
{
    final String strSource = fault.getSource();
    final String strFaultCode = fault.getFaultCode();
    if (strFaultCode != null && strFaultCode.equalsIgnoreCase("FileNotFound"))
    {
        this.strErrorMsg = fault.getFaultString() + ": " + strSource;
    }
    else
    {
        this.strErrorMsg = fault.getFaultString() + ": " + strSource;
    }
}
```

Step 6: Simplify

- In this simple example, you will find an exact duplication of the statements in the `if` and `else` block.

```
catch (final Fault fault)
{
    final String strSource = fault.getSource();
    final String strFaultCode = fault.getFaultCode();

    this.strErrorMsg = fault.getFaultString() + ": " + strSource;
}
```

Applying checklist

Step 5: Clean Up

- As a result of these simplifications it becomes obvious that the variable `strFaultCode` is now unused and thus superfluous. Thus it can be dropped. Also the variable `strSource` determines only data from the passed fault object.

```
catch (final Fault fault)
{
    this.strErrorMsg = fault.getFaultString() + ": " + fault.getSource();
}
```

Conclusion

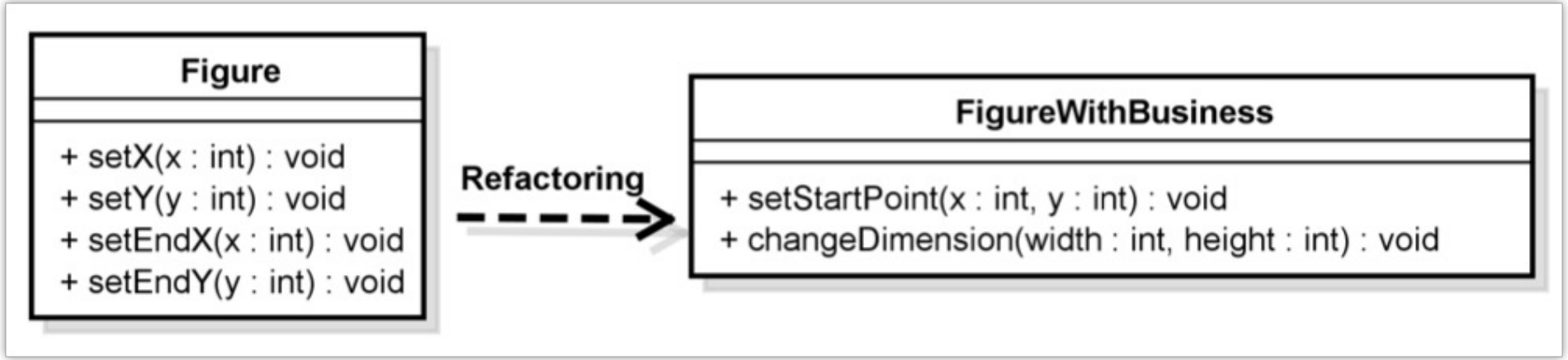
- The result is impressive: Ten lines of source code have become one line. Just as bad smells spread when you are careless, there is fortunately also an opposite effect: **the more you ensure clarity and structure, the easier it is to make further improvements**.

- However, we have not been able to remove one problem: There is still an assignment to the `strErrorMsg` attribute in the catch block. Such a side effect should be avoided, since state changes occur at unexpected places in the program. **During refactorings we normally do not want to change the externally visible program behavior, but only improve the inner structure.**

Catalog of «bigger» refactorings

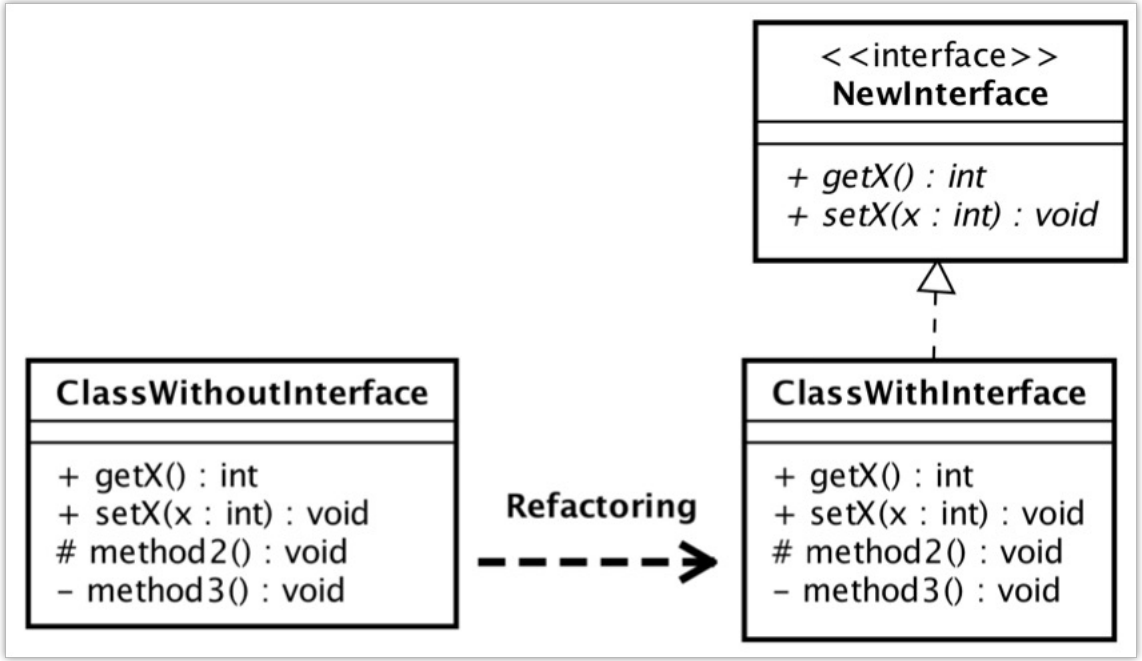
Replace Mutator with Business Method

- **This refactoring helps to protect the state of an object from fine-grained changes and addresses the object-oriented idea of defining behavior through business methods.**



Introduce an interface

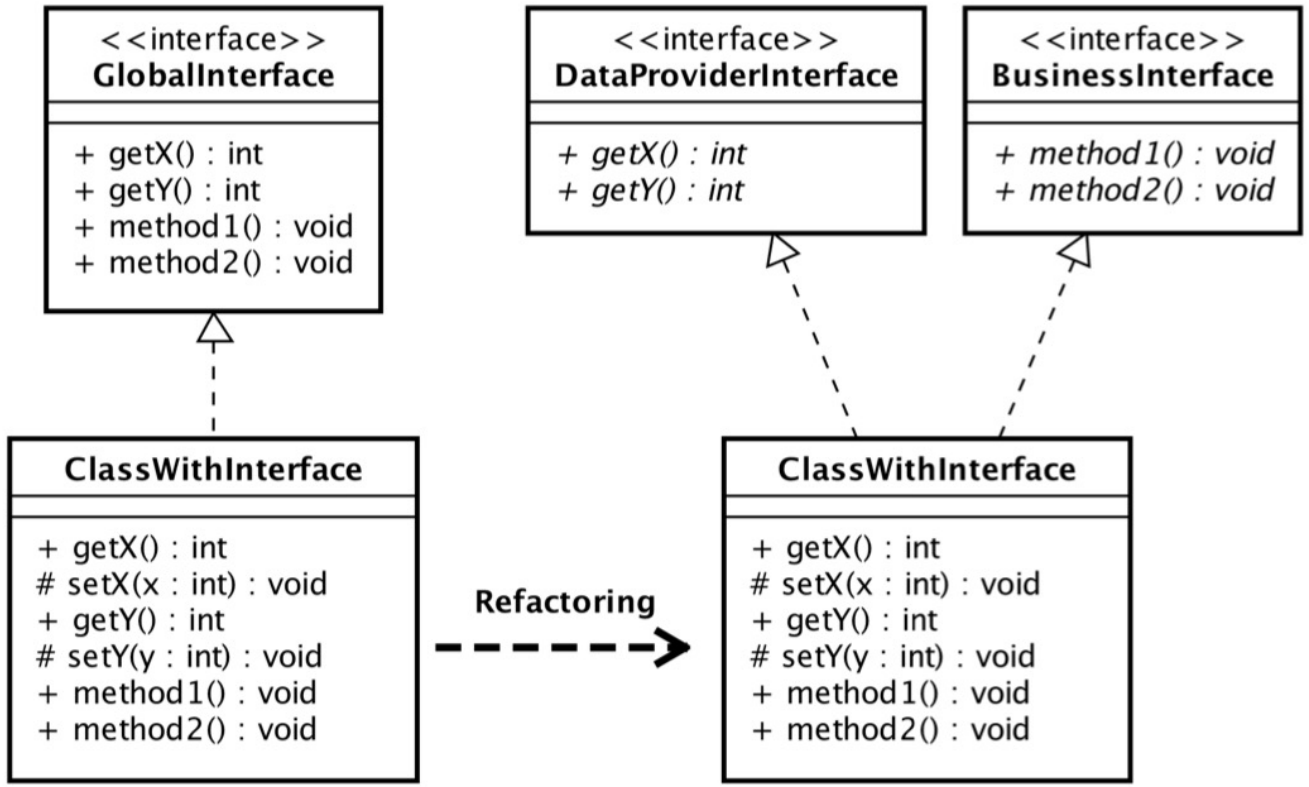
- **Turn an existing class without an explict interface into a class that offers an interface.* With this refactoring we bundle the desired public methods in an explicit interface.**
- **Pay attention: this does not make sense in every case, for example for only internal classes, but it does for classes with a public interface.**



*every class has an interface, namely the public and protected methods, but explict interface uses keyword `interface`

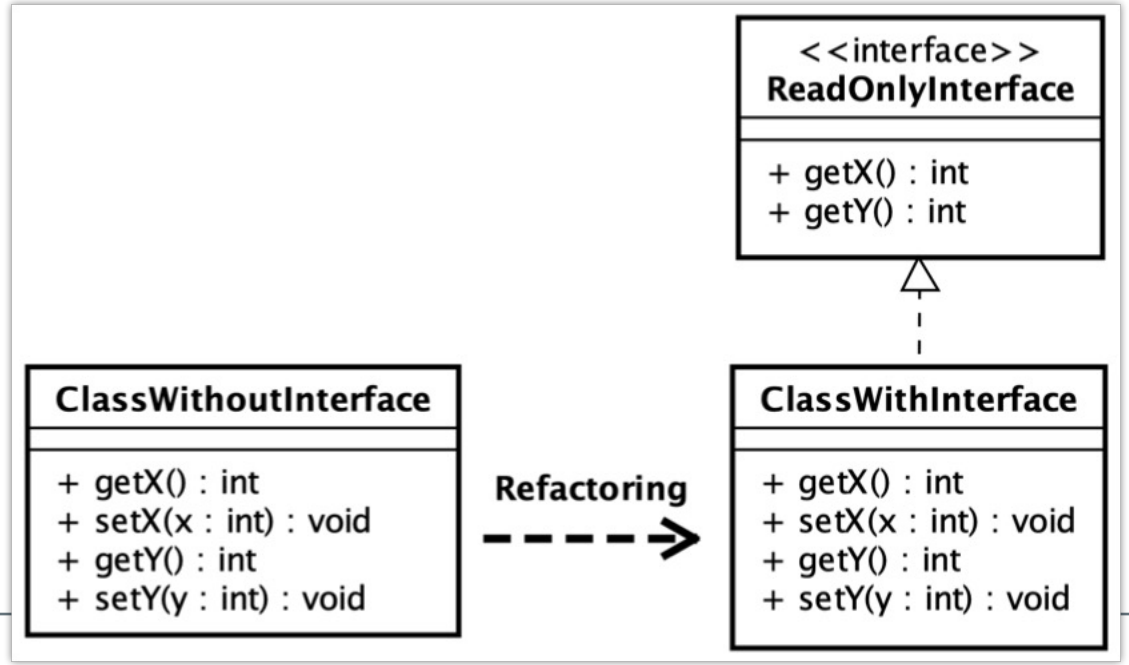
Split interface

- **Sometimes during development you realize that an interface should better be split into two or more interfaces.**
- **As an example, the interface `GlobalInterface` will be split in the following, since it offers business functionality in addition to pure read access.**



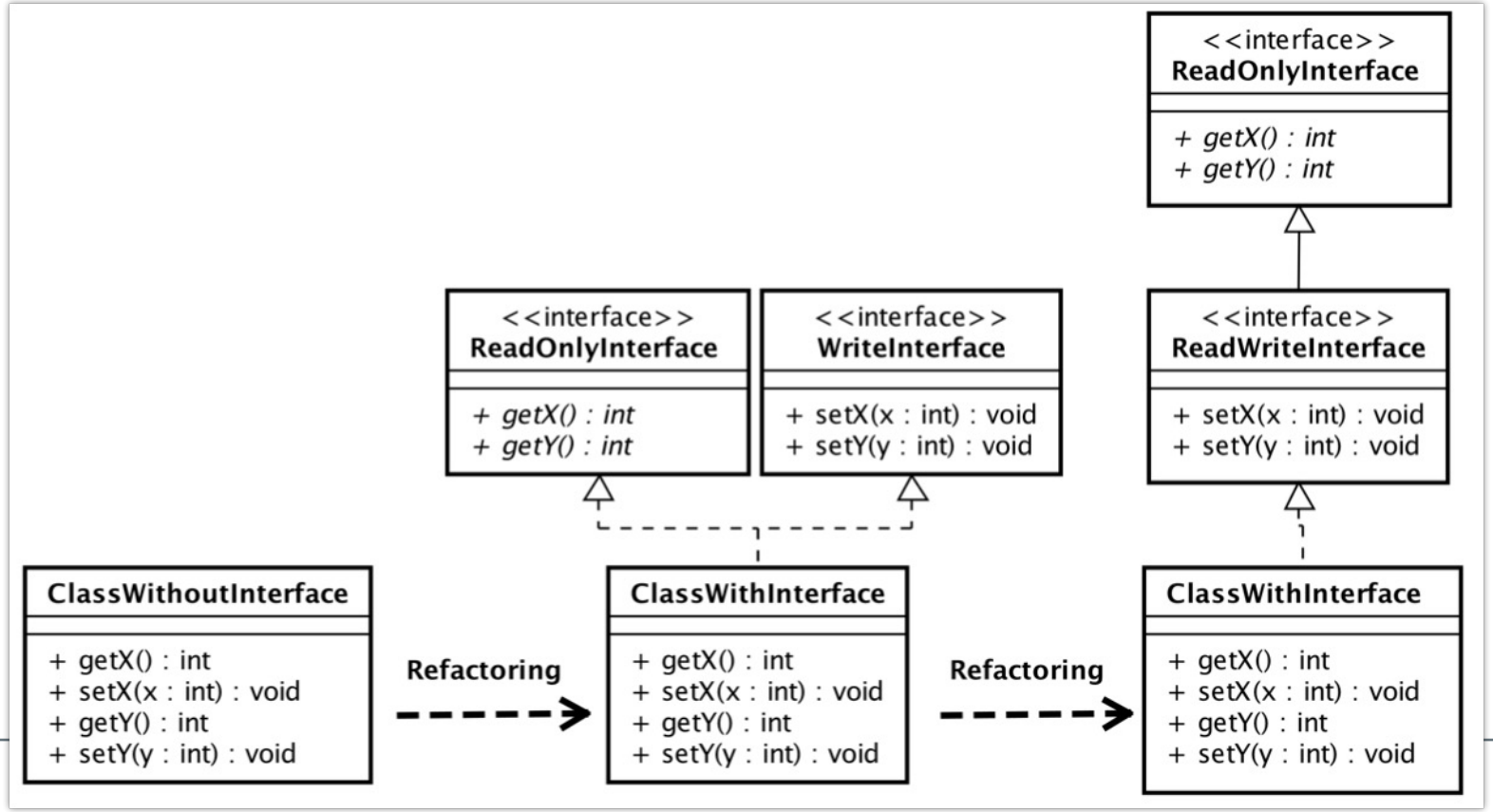
Introduce a read-only interface

- In more complex systems, providing read-only interfaces can be useful to protect against unwanted changes by other components.
- Without access protection, the model data could be modified not only internally, but also by external clients. To prevent this, one can introduce a read-only interface



Introduce a read-write interface

- **Read-only interfaces can be used to prevent write access by package-external classes. Some components should have write access, but under the premise without direct access to concrete objects. In this case, you can define a special interface that only provides write access:**



Separate information acquisition / retrival and processing

Separate information acquisition / retrival and processing

- **In many cases, it is advantageous to separate the acquisition of information from its processing and storage.**

- **These subtasks can generally be outsourced quite well to separate methods, which increases orthogonality (combinability) and reusability and avoids invalid intermediate states.**

Separate information acquisition / retrival and processing

- **Five `set()` calls are distributed all over the method. This seems harmless.**

```
public void updateModelFromElement(final DataElementVO elementVO)
{
    if (elementVO != null) {
        if (elementVO.getQueueStatus() != null) {
            model.setState(elementVO.getQueueStatus());
        }
        else {
            model.setState(QueueStates.UNKNOWN);
        }
        model.setQueuedJobs(elementVO.getEntryCount());
    }
    else {
        model.setState(QueueStates.UNREACHABLE);
        model.setQueuedJobs(0);
    }
}
```

- **However, one should keep in mind that in principle an error can occur with every method call and as a consequence an exception can be thrown. This can lead to inconsistencies due to partially initialized objects.**

Separate information acquisition / retrival and processing
Step 1: Detect changing elements and introduce auxiliary variables

- **in the if- and else respectively two variables are changed by set() calls.**

```
public void updateModelFromElement(final DataElementVO elementVO)
{
   if (elementVO != null) {
       if (elementVO.getQueueStatus() != null) {
           model.setState(elementVO.getQueueStatus());
       }
       else {
           model.setState(QueueStates.UNKNOWN);
       }
       model.setQueuedJobs(elementVO.getEntryCount());
    }
    else {
        model.setState(QueueStates.UNREACHABLE);
        model.setQueuedJobs(0);
    }
}
```

- **Introduce corresponding auxiliary variables `state` and `entryCount`. The basic refactoring EXTRACT LOCAL VARIABLE helps us with this.**

Separate information acquisition / retrival and processing
Step 1: Detect changing elements and introduce auxiliary variables

- **Introduce corresponding auxiliary variables `state` and `entryCount`. The basic refactoring EXTRACT LOCAL VARIABLE helps us with this**

```
public void updateModelFromElement(final DataElementVO elementVO) {
    if (elementVO != null) {
        QueueStates state = elementVO.getQueueStatus();
        if (queueStatus != null) {
            model.setState(state);
        } else {
            QueueStates state2 = QueueStates.UNKNOWN;
            model.setState(state2);
        }
        int entryCount = elementVO.getEntryCount();
        model.setQueuedJobs(entryCount);
    } else {
        QueueStates state = QueueStates.UNREACHABLE;
        model.setState(state);
        int entryCount = 0;
        model.setQueuedJobs(entryCount);
    }
}
```

Separate information acquisition / retrival and processing
Step 2: Combine the `set()` methods

- **Move some lines up and down to group read / write access**

```
public void updateModelFromElement(final DataElementVO elementVO) {
    if (elementVO != null) {
        QueueStates state = elementVO.getQueueStatus();
        if (state == null) {
            state = QueueStates.UNKNOWN;
        }
        int entryCount = elementVO.getEntryCount();

        model.setState(state);
        model.setQueuedJobs(entryCount);
    }
    else {
        QueueStates state = QueueStates.UNREACHABLE;
        int entryCount = 0;

        model.setState(state);
        model.setQueuedJobs(entryCount);
    }
}
```

Separate information acquisition / retrival and processing
Step 3: Separate information acquisition / retrival and processing

- **Move some lines up and down to group read / write access**

```
public void updateModelFromElement(final DataElementVO elementVO) {
    if (elementVO != null) {
        QueueStates state = elementVO.getQueueStatus();
        if (state == null) {
            state = QueueStates.UNKNOWN;
        }
        int entryCount = elementVO.getEntryCount();

        model.setState(state);
        model.setQueuedJobs(entryCount);
    }
    else {
        QueueStates state = QueueStates.UNREACHABLE;
        int entryCount = 0;

        model.setState(state);
        model.setQueuedJobs(entryCount);
    }
}
```

GOAL: Move them to the end

Separate information acquisition / retrival and processing

Step 3: Separate information acquisition / retrival and processing

```
public void updateModelFromElement(final DataElementVO elementVO) {
    if (elementVO != null) {
        QueueStates state = elementVO.getQueueStatus();
        if (state ==
            state = Q
        }
        int entryCoun

        model.setStat
        model.setQueu
    } else {
        QueueStates s
        int entryCoun

        model.setState(state);
        model.setQueuedJobs(entryCount);
    }
}
```

Rename in file (⌘2 R)
Rename in workspace
Change type of 'state' to 'var'
Convert local variable to field
Split variable declaration

Separate information acquisition / retrival and processing
Step 3: Separate information acquisition / retrival and processing

```
public void updateModelFromElement(final DataElementVO elementVO) {
    if (elementVO != null) {
        QueueStates state;
        state = elementVO.getQueueStatus();
        if (state == null) {                                    information retrival
            state = QueueStates.UNKNOWN;
        }
        int entryCount;
        entryCount = elementVO.getEntryCount();

        model.setState(state);
        model.setQueuedJobs(entryCount);                        processing
    } else {
        QueueStates state;
        state = QueueStates.UNREACHABLE;
        int entryCount;                                         information retrival
        entryCount = 0;

        model.setState(state);
        model.setQueuedJobs(entryCount);                        processing
    }
}
```

Separate information acquisition / retrival and processing
Step 3: Separate information acquisition / retrival and processing

```
public void updateModelFromElement(final DataElementVO elementVO) {
    QueueStates state;
    int entryCount;

    if (elementVO != null) {
        state = elementVO.getQueueStatus();
        if (state == null) {
            state = QueueStates.UNKNOWN;
        }
        entryCount = elementVO.getEntryCount();

        model.setState(state);
        model.setQueuedJobs(entryCount);
    } else {
        QueueStates state;
        state = QueueStates.UNREACHABLE;
        int entryCount;
        entryCount = 0;

        model.setState(state);
        model.setQueuedJobs(entryCount);
    }
}
```

information retrival

processing

information retrival

processing

Separate information acquisition / retrival and processing
Step 3: Separate information acquisition / retrival and processing

```
public void updateModelFromElement(final DataElementVO elementVO) {
    QueueStates state;
    int entryCount;

    if (elementVO != null) {
        state = elementVO.getQueueStatus();
        if (state == null) {
            state = QueueStates.UNKNOWN;
        }                                                    information retrival
        entryCount = elementVO.getEntryCount();
    } else {
        state = QueueStates.UNREACHABLE;
        entryCount = 0;
    }

    model.setState(state);
    model.setQueuedJobs(entryCount);                         processing
}
```

Separate information acquisition / retrival and processing
Step 4: Encapsulate information gathering and processing

```
public void updateModelFromElement(final DataElementVO elementVO) {
    QueueStates state;
    int entryCount;

    if (elementVO != null) {
        state = elementVO.getQueueStatus();
        if (state == null) {
            state = QueueStates.UNKNOWN;
        }
        entryCount = elementVO.getEntryCount();
    } else {
        state = QueueStates.UNREACHABLE;
        entryCount = 0;
    }

    storeInModel(state, entryCount);
}

public void storeInModel(QueueStates state, int entryCount) {
    model.setState(state);
    model.setQueuedJobs(entryCount);
}
```

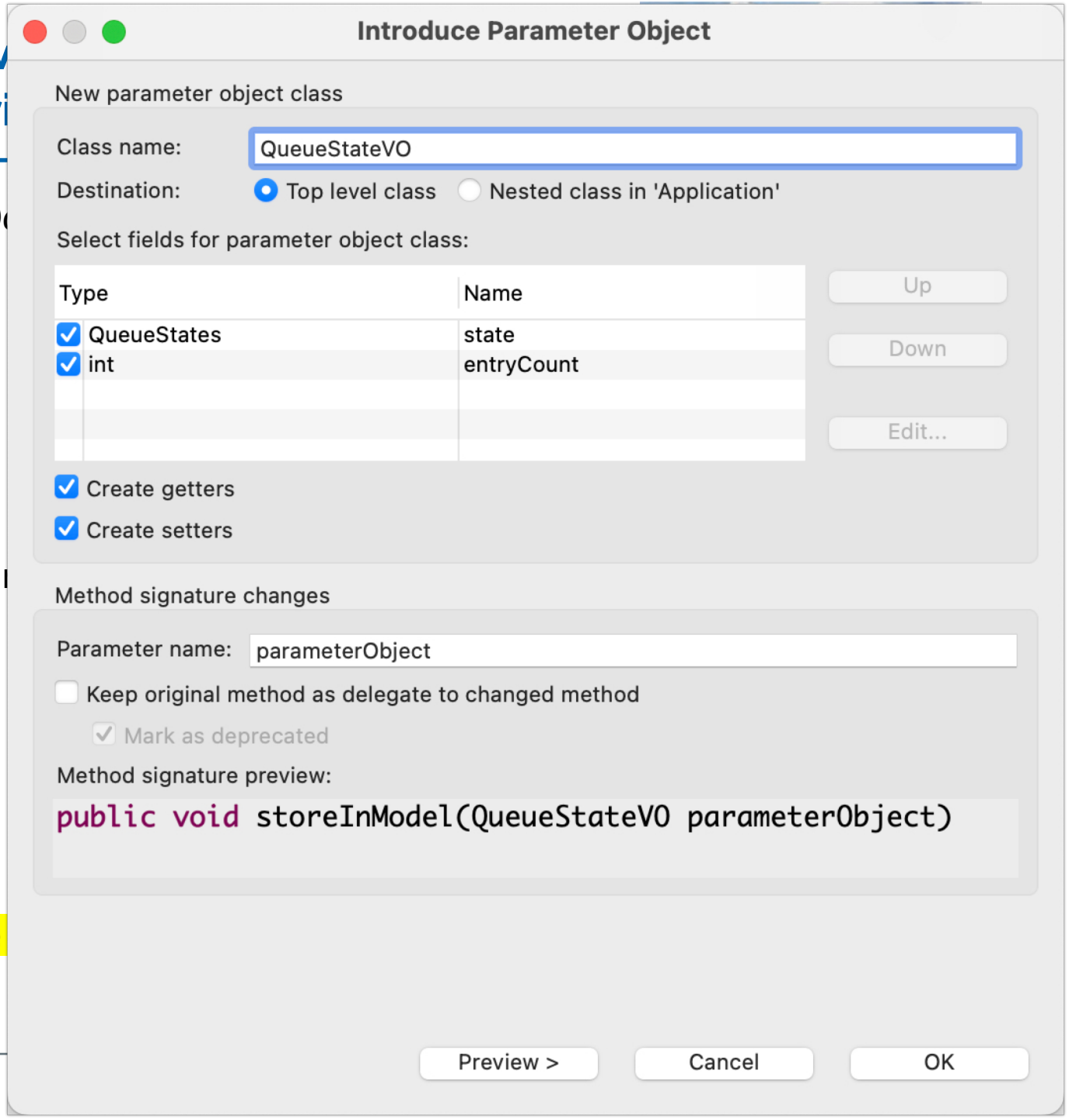
Separate information acquisition / retriv
Step 4: Encapsulate information gatheri

```
public void updateModelFromElement(final D
    QueueStates state;
    int entryCount;

    if (elementVO != null) {
        state = elementVO.getQueueStatus()
        if (state == null) {
            state = QueueStates.UNKNOWN;
        }
        entryCount = elementVO.getEntryCou
    } else {
        state = QueueStates.UNREACHABLE;
        entryCount = 0;
    }

    storeInModel(state, entryCount);
}

public void storeInModel(QueueStates state
    model.setState(state);
    model.setQueuedJobs(entryCount);
}
```



Separate information acquisition / retrival and processing
Step 5: Finetune

```
public class QueueStateVO {
    private QueueStates state;
    private int entryCount;

    public QueueStateVO(QueueStates state, int entryCount) {
        this.state = state;
        this.entryCount = entryCount;
    }

    public QueueStates getState() {
        return state;
    }

    public void setState(QueueStates state) {
        this.state = state;
    }

   public int getEntryCount() {
   …
```

Separate information acquisition / retrival and processing
Step 4: Encapsulate information gathering and processing

```
public void updateModelFromElement(final DataElementVO elementVO) {
    QueueStates state;
    int entryCount;

    if (elementVO != null) {
        state = elementVO.getQueueStatus();
        if (state == null) {
            state = QueueStates.UNKNOWN;
        }
        entryCount = elementVO.getEntryCount();
    } else {
        state = QueueStates.UNREACHABLE;
        entryCount = 0;
    }

    QueueStateVO parameterObject = new QueueStateVO(state, entryCount);
    storeInModel(parameterObject);
}

public void storeInModel(QueueStateVO parameterObject) {
    model.setState(parameterObject.getState());
    model.setQueuedJobs(parameterObject.getEntryCount());
}
```

Separate information acquisition / retrival and processing
Step 4: Encapsulate information gathering and processing

```
public void updateModelFromElement(final DataElementVO elementVO) {
    QueueStates state;
    state = QueueStates.UNREACHABLE;
    int entryCount;
    entryCount = 0;

    if (elementVO != null) {
        state = elementVO.getQueueStatus();
        if (state == null) {
            state = QueueStates.UNKNOWN;
        }
        entryCount = elementVO.getEntryCount();
    } else {
    }

    QueueStateVO parameterObject = new QueueStateVO(state, entryCount);
    storeInModel(parameterObject);
}
```

Separate information acquisition / retrival and processing
Step 4: Encapsulate information gathering and processing

```
public void updateModelFromElement(final DataElementVO elementVO) {
    QueueStates state;
    state = QueueStates.UNREACHABLE;
    int entryCount;
    entryCount
                                  Rename in file (⌘2 R)
                                  Rename in workspace
                                  Convert local variable to field
                                  Join variable declaration
    if (elemen
        state
        if (st
            st
        }
        entryC
    }

    QueueStateVO parameterObject = new QueueStateVO(state, entryCount);
    storeInModel(parameterObject);
}
```

Separate information acquisition / retrival and processing
Step 4: Encapsulate information gathering and processing

```
public void updateModelFromElement(final DataElementVO elementVO) {
    QueueStateVO parameterObject = retrieveData(elementVO);

    storeInModel(parameterObject);
}

public QueueStateVO retrieveData(final DataElementVO elementVO) {
    QueueStates state = QueueStates.UNREACHABLE;
    int entryCount = 0;

    if (elementVO != null) {
        state = elementVO.getQueueStatus();
        if (state == null) {
            state = QueueStates.UNKNOWN;
        }
        entryCount = elementVO.getEntryCount();
    }
    QueueStateVO parameterObject = new QueueStateVO(state, entryCount);
    return parameterObject;
}
```

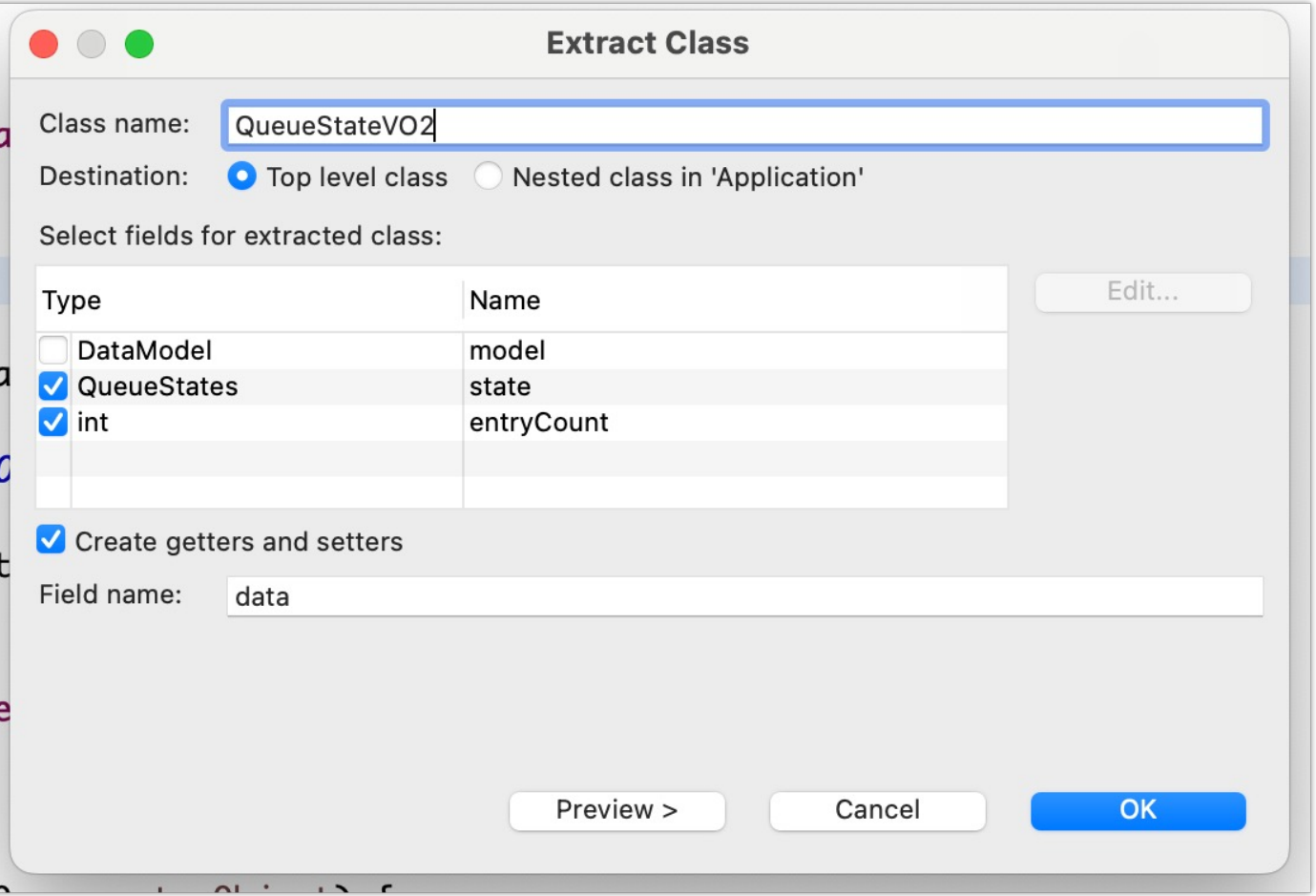
Separate information acquisition / retrival and processing
Step 4: Finetune I – if you like get() / set() to be adjusted

```
}

public QueueStateVO retrieveData(fina
    state = QueueStates.UNREACHABLE;
    entryCount = 0;

    if (elementVO != null) {
        state = elementVO.getQueueSta
        if (state == null) {
            state = QueueStates.UNKNO
        }
        entryCount = elementVO.getEnt
    }

    QueueStateVO parameterObject = ne
    return parameterObject;
}
```



Separate information acquisition / retrival and processing
Step 4: Finetune II – move var up and adjust assignments by hand

```
public void updateModelFromElement(final DataElementVO elementVO) {
    QueueStateVO parameterObject = retrieveData(elementVO);

    storeInModel(parameterObject);
}

public QueueStateVO retrieveData(final DataElementVO elementVO) {
    QueueStateVO parameterObject = new QueueStateVO(QueueStates.UNREACHABLE, 0);

    if (elementVO != null) {
        parameterObject.setState(elementVO.getQueueStatus());
        if (parameterObject.getState() == null) {
            parameterObject.setState(QueueStates.UNKNOWN);
        }
        parameterObject.setEntryCount(elementVO.getEntryCount());
    }
    return parameterObject;
}

public void storeInModel(QueueStateVO parameterObject) {
    model.setState(parameterObject.getState());
    model.setQueuedJobs(parameterObject.getEntryCount());
}
```

Separate information acquisition / retrival and processing
Step 5: Move to QueueStateVO

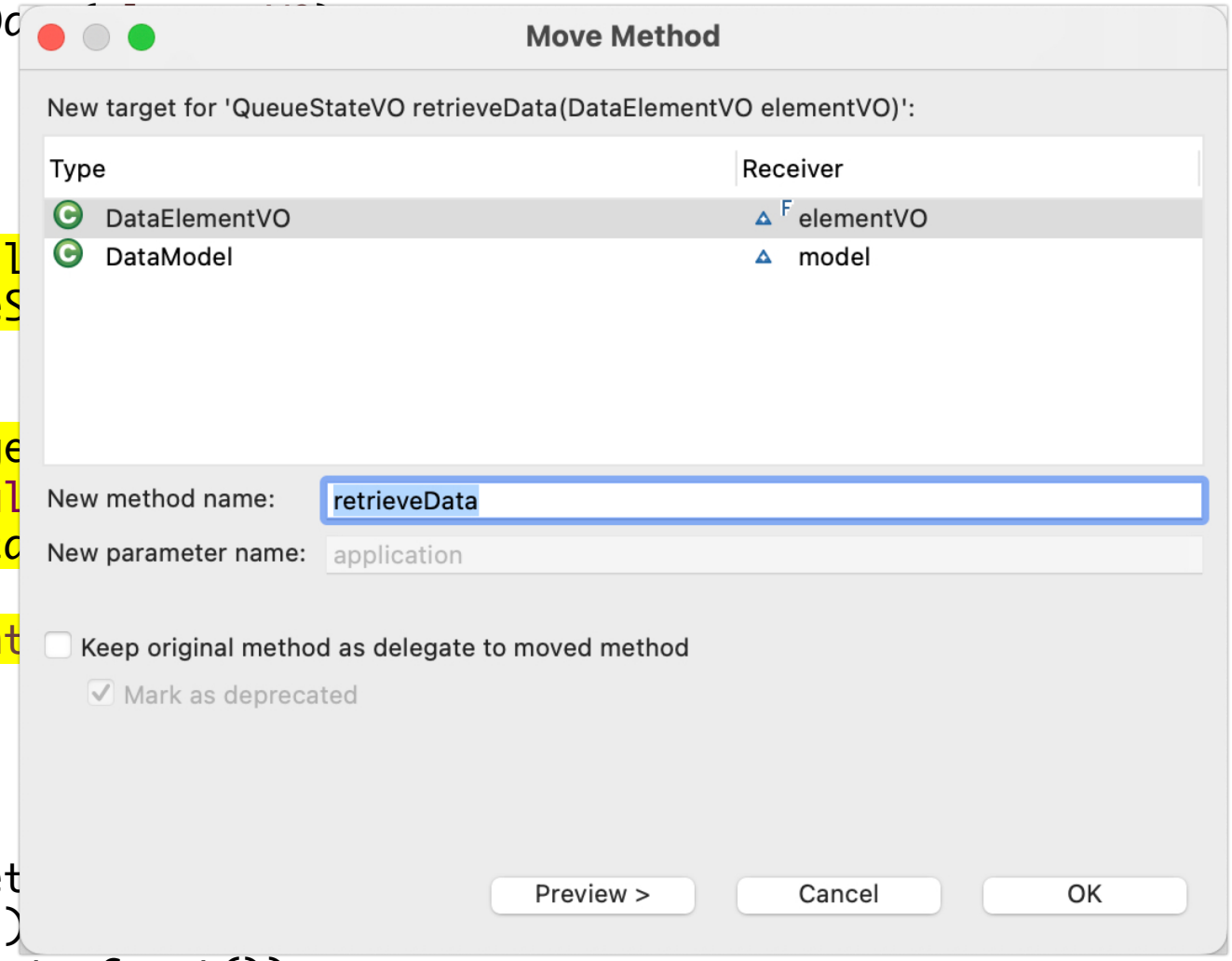
```
public void updateModelFromElement(final DataElementVO elementVO) {
    QueueStateVO parameterObject = retrieveDa

    storeInModel(parameterObject);
}

public QueueStateVO retrieveData(final DataEl
    QueueStateVO parameterObject = new QueueS

    if (elementVO != null) {
        parameterObject.setState(elementVO.ge
        if (parameterObject.getState() == nul
            parameterObject.setState(QueueSta
        }
        parameterObject.setEntryCount(element
    }
    return parameterObject;
}

public void storeInModel(QueueStateVO paramet
    model.setState(parameterObject.getState()
    model.setQueuedJobs(parameterObject.getEntryCount());
}
```



But how to move it to QueueStateVO?

Separate information acquisition / retrival and processing
Step 5: Move to QueueStateVO

Change Method Signature

Access modifier: public

Return type: QueueStateVO

Method name: retrieveData

Parameters | Exceptions

Type	Name	Default value
DataElementVO	elementVO	-
QueueStateVO	**tmp**	**new QueueStateVO(null, 0)**

Add | Edit... | Remove | Up | Down

Keep original method as delegate to changed method

Mark as deprecated

Method signature preview:

```
public QueueStateVO retrieveData(DataElementVO elementVO, QueueStateVO tmp)
```

Preview > | Cancel | OK

Separate information acquisition / retrival and processing
Step 5: Move to QueueStateVO

```
public QueueStateVO retrieveData(final DataElementVO elementVO, QueueStateVO tmp) {
    QueueStateVO parameterObje

    if (elementVO != null) {
        parameterObject.setSta
        if (parameterObject.ge
            parameterObject.se
        }
        parameterObject.setEnt
    }

    return parameterObject;
}

public void storeInModel(Queue
    model.setState(parameterOb
    model.setQueuedJobs(parame
}
}
```

oblems @ Javadoc Declaration

Move Method

New target for 'QueueStateVO retrieveData(DataElementVO elementVO, QueueStateVO tmp)':

Type	Receiver
DataElementVO	F elementVO
QueueStateVO	tmp
DataModel	model

New method name: fromDataElementVO

New parameter name: application

Keep original method as delegate to moved method

Mark as deprecated

Preview > Cancel OK

Separate information acquisition / retrival and processing
Step 5: Move to QueueStateVO

```
public static QueueStateVO fromDataElementVO(final DataElementVO elementVO) {
    QueueStateVO parameterObject = new QueueStateVO(QueueStates.UNREACHABLE, 0);

    if (elementVO != null) {
        parameterObject.setState(elementVO.getQueueStatus());
        if (parameterObject.getState() == null) {
            parameterObject.setState(QueueStates.UNKNOWN);
        }
        parameterObject.setEntryCount(elementVO.getEntryCount());
    }
    return parameterObject;
}
```

Separate information acquisition / retrival and processing
Step 5: Move to QueueStateVO

```
public void updateModelFromElement(final DataElementVO elementVO) {
    QueueStateVO parameterObject = QueueStateVO.fromDataElementVO(elementVO);

    storeInModel(parameterObject);
}


public void storeInModel(QueueStateVO parameterObject) {
    model.setState(parameterObject.getState());
    model.setQueuedJobs(parameterObject.getEntryCount());
}
```

Resolve if-else / instanceof by polymorphism

Resolve if-else / instanceof by polymorphism

```
for (final Object obj : figures)
{
    if (obj instance Rect)
    {
        ((Rect)obj).drawRect();
    }
    else if (obj instance Line)
    {
        ((Line)obj).drawLine();
    }
    else if (obj instance Circle)
    {
        ((Circle)obj).drawCircle();
    }
}
```

Resolve if-else / instanceof by polymorphism

With a little programming experience it is obvious that this is a strange construct and here is an indication for the use of polymorphism. We transform the source code in the following three steps:

1. interface unification – introduce common method `draw()`
2. introduce common base type `BaseFigure`
3. adaptation of the caller

```
for (final Object obj : figures)
{
    if (obj instance Rect)
    {
        ((Rect)obj).drawRect();
    }
    else if (obj instance Line)
    {
        ((Line)obj).drawLine();
    }
    else if (obj instance Circle)
    {
        ((Circle)obj).drawCircle();
    }
}
```

Resolve if-else / instanceof by polymorphism

1. **interface unification – introduce common method `draw()`**
2. introduce common base type `BaseFigure`
3. adaptation of the caller

```
for (final Object obj : figures)
{
    if (obj instance Rect)
    {
        ((Rect)obj).draw();
    }
    else if (obj instance Line)
    {
        ((Line)obj).draw();
    }
    else if (obj instance Circle)
    {
        ((Circle)obj).draw();
    }
}
```

Resolve if-else / instanceof by polymorphism

1. interface unification – introduce common method `draw()`
2. **introduce common base type `BaseFigure`**
3. adaptation of the caller

```
public interface BaseFigure
{
    public abstract void draw();
}
```

Resolve if-else / instanceof by polymorphism

1. interface unification – introduce common method `draw()`
2. introduce common base type `BaseFigure`
3. **adaptation of the caller**

```
for (final BaseFigure baseFigure : figures)
{
    baseFigure.draw();
}
```

Defensive programming

Defensive programming

1. In (more) complex systems with many components and external calls, it is recommended to program carefully or defensively, especially at the system or component boundaries.

2. By this is meant that one validates inputs and checks correct initializations and states. (Pre- / Postconditions, Invariants and Design By Contract)

3. Input parameter checking helps to reject unexpected values. This preserves object integrity and method execution only occurs under safe environmental conditions.

4. Furthermore, we can make our software more informative in case of errors. As a reaction to invalid parameter values one should raise exceptions,* since these can supply a caller with a quantity of information about a possible error cause in contrast to return values.

*why not using keyword `assert`? => can be deactivated, and is by default

Defensive programming

1. Ensure that methods get called with valid data and fail fast if this is not the case

2. Please don‘t overdo it: Checks are not needed and reasonable in every method, this applys foremost to private methods

3. Why?
    1. To avoid that half of your code consists of sanity checks
    2. Because for private methods you are in charge to ensure validity and integrity of parameters passed

    ANALOGY: If you leave your dirty shoes outside your front door, you don't have to keep cleaning the floor of your entire apartment after a walk in the woods.

4. Just check at the system borders and for public methods which build up the API for your subsystem

    ANALOGY: If you already check IDs and goods at the border, then you don't have to do it again and again throughout the country.

State checks

Defensive programming – Starting point

- Lot‘s of sanity checks for the API
- A lot of duplicated code

```
public static final String getExternalNameServiceName()
{
   if (parameterAccessService == null)
     throw new IllegalStateException("ParameterAccessService is not correctly" +
                 " initialized. Use initialize() before any other method call.");

   return parameterAccessService.getValue("SYSPARAM_EXTERNAL_NAME_SERVICE");
}

public static final String getExternalORBHost()
{
   if (parameterAccessService == null)
     throw new IllegalStateException("ParameterAccessService is not correctly" +
                 " initialized. Use initialize() before any other method call.");

   return parameterAccessService.getValue("SYSPARAM_EXTERNAL_ORB_HOST");
}

public static final String getInternalORBHost()
{
   if (parameterAccessService == null)
     throw new IllegalStateException("ParameterAccessService is not correctly" +
                 " initialized. Use initialize() before any other method call.");

   return parameterAccessService.getValue("SYSPARAM_INTERNAL_ORB_HOST");
}
```

Step 1: Implement / extract validation method(s)

```
private static void checkParameterAccessServiceInitialized()
{
   if (parameterAccessService == null)
     throw new IllegalStateException("ParameterAccessService is not correctly" +
                 " initialized. Use initialize() before any other method call.");
}
```

Step 2: Usage of validation method(s)

```
public static final String getExternalNameServiceName()
{
    checkParameterAccessServiceInitialized();
    return parameterAccessService.getValue("SYSPARAM_EXTERNAL_NAME_SERVICE");
}

public static final String getExternalORBHost()
{
    checkParameterAccessServiceInitialized();
    return parameterAccessService.getValue("SYSPARAM_EXTERNAL_ORB_HOST");
}

public static final String getInternalORBHost()
{
    checkParameterAccessServiceInitialized();
    return parameterAccessService.getValue("SYSPARAM_INTERNAL_ORB_HOST");
}
```

Parameter checks

Defensive programming – Starting point

- **No parameter checks at all**

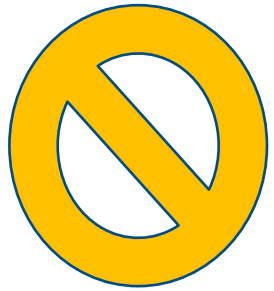
```
public CommandExecutor(final int minExecutions, final int maxExecutions,
                       final int registrationStrategy)
{
    this.minExecutions = minExecutions;
    this.maxExecutions = maxExecutions;
    this.registrationStrategy = registrationStrategy;
}
```

Defensive programming

- **Step 1: Adding checks**

```
public CommandExecutor(final int minExecutions, final int maxExecutions, final
      int registrationStrategy)
{
    if (minExecutions < 0 || maxExecutions > MAX_EXECUTIONS)
    {
        throw new IllegalArgumentException("parameter 'minExecutions' or " +
                                           "'maxExecutions' is out of valid range");
    }
    if (minExecutions > maxExecutions)
    {
        throw new IllegalArgumentException("parameter 'minExecutions' must be" +
                                           " <= 'maxExecutions'");
    }
    // Achtung: Hier korrekter, aber potenziell fehlerträchtiger und fragiler
    // Vergleich, weil das Ganze stark vom Mapping und Werten abhängig ist!
    if (registrationStrategy < REPLACE_OLD_OR_ADD_AS_LAST ||
        registrationStrategy > ADD_AS_LAST)
    {
        throw new IllegalArgumentException("parameter 'registrationStrategy'" +
                                           " is invalid");
    }

    this.minExecutions = minExecutions;
    this.maxExecutions = maxExecutions;
    this.registrationStrategy = registrationStrategy;
}
```



Defensive programming

- **Step 2: Use of enumerations when useful and possible**

```
public CommandExecutor(final int minExecutions, final int maxExecutions,
                       final RegistrationStrategy registrationStrategy)
{
   // ... zwei Prüfungen ausgelassen ...
   Objects.requireNonNull(registrationStrategy,
                          "parameter 'registrationStrategy' must not be null");

   this.minExecutions = minExecutions;
   this.maxExecutions = maxExecutions;
   this.registrationStrategy = registrationStrategy;
}
```

Defensive programming

- **Step 3: Specification of passed values and of validity areas**

```
public CommandExecutor(final int minExecutions, final int maxExecutions,
                       final RegistrationStrategy registrationStrategy)
{
   if (minExecutions < 0 || maxExecutions > MAX_EXECUTIONS)
   {
      throw new IllegalArgumentException("parameter 'minExecutions'=" +
                minExecutions + " or 'maxExecutions'=" + maxExecutions +
                " is out of valid range: [" + 0 + " - " + MAX_EXECUTIONS + "]");
   }
   if (minExecutions > maxExecutions)
   {
      throw new IllegalArgumentException("parameter 'minExecutions'=" +
                minExecutions + " must be <= 'maxExecutions'=" + maxExecutions);
   }

   Objects.requireNonNull(registrationStrategy,
                          "parameter 'registrationStrategy' must not be null");

   this.minExecutions = minExecutions;
   this.maxExecutions = maxExecutions;
   this.registrationStrategy = registrationStrategy;
}
```

Defensive programming

- **Step 4: Extraction of validation / range checker methods**

```
public CommandExecutor(final int minExecutions, final int maxExecutions,
                       final RegistrationStrategy registrationStrategy)
{
    assertExecutionsInValidRange(minExecutions, maxExecutions);
    assertMinExecutionsLessOrEqualToMax(minExecutions, maxExecutions);
    Objects.requireNonNull(registrationStrategy,
                           "parameter 'registrationStrategy' must not be null");

    this.minExecutions = minExecutions;
    this.maxExecutions = maxExecutions;
    this.registrationStrategy = registrationStrategy;
}
```

Defensive programming

- **Step 4: Extraction of validation / range checker methods II**

```
static void assertExecutionsInValidRange(final int minExecutions,
                                         final int maxExecutions)
{
    if (minExecutions < 0 || maxExecutions > MAX_EXECUTIONS)
    {
        throw new IllegalArgumentException("parameter 'minExecutions'=" +
              minExecutions + " or 'maxExecutions'=" + maxExecutions +
              " is out of valid range: [" + 0 + " - " + MAX_EXECUTIONS + "]");
    }
}

static void assertMinExecutionsLessOrEqualToMax(final int minExecutions,
                                                final int maxExecutions)
{
    if (minExecutions > maxExecutions)
    {
        throw new IllegalArgumentException("parameter 'minExecutions'=" +
              minExecutions + " must be <= 'maxExecutions'=" + maxExecutions);
    }
}
```

Exercises

https://github.com/Michaeli71/ADC_BOOTCAMP_REFACTORINGS

Take Aways

Check List Summary

1. Run Tests
2. Apply Coding Conventions
3. Break down into individual parts
4. Write unit tests
5. Clean Up
6. Simply unit tests
7. Perform concrete refactorings unit tests

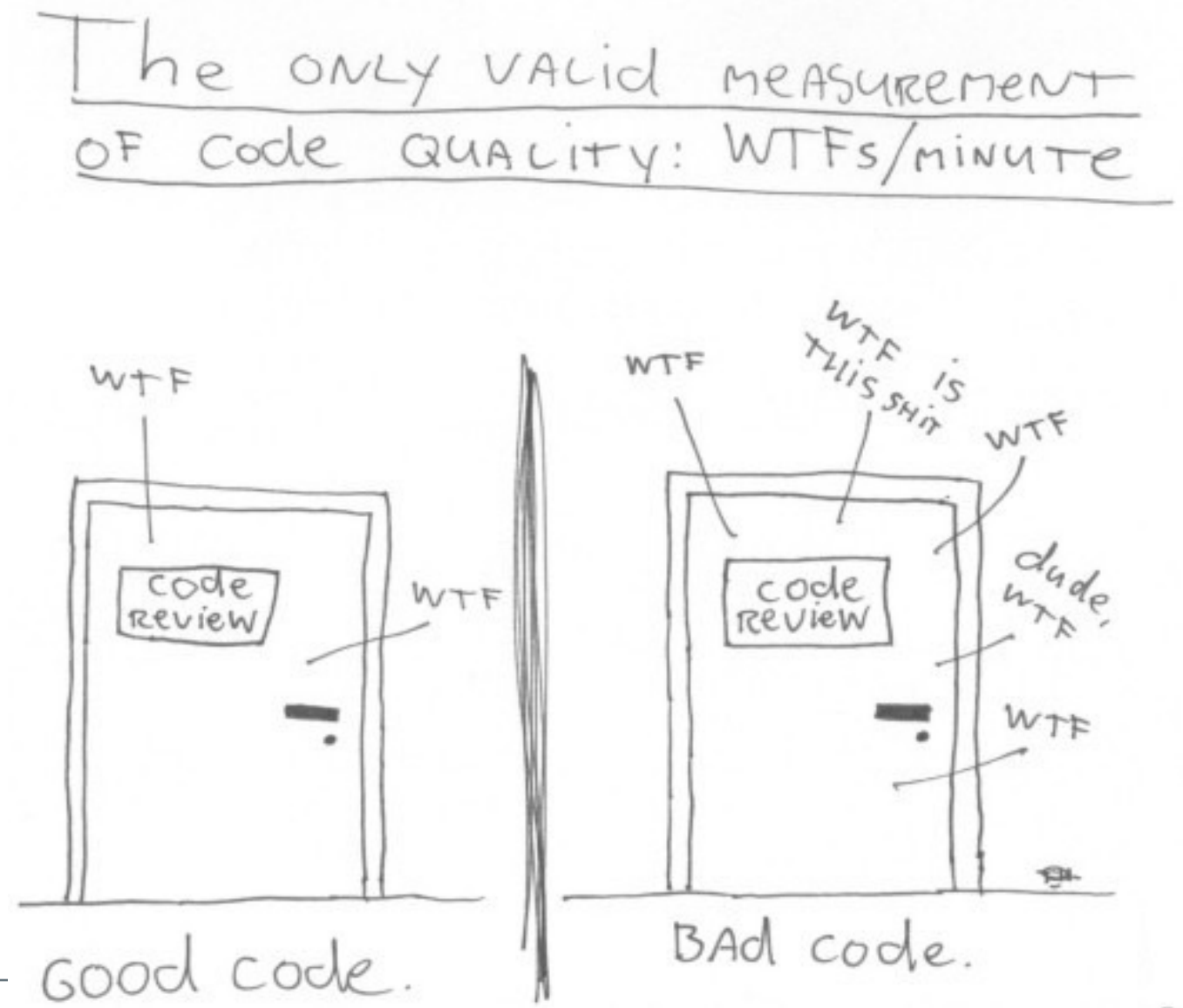
Take Away: Read vs. Write

We READ 10x more time than we WRITE

→ **Make it more readable**, even if it's harder to write

Take Away: Boyscout Rule
Leave the campground cleaner than you found it

Take Away: WTF – The TRUE measurement



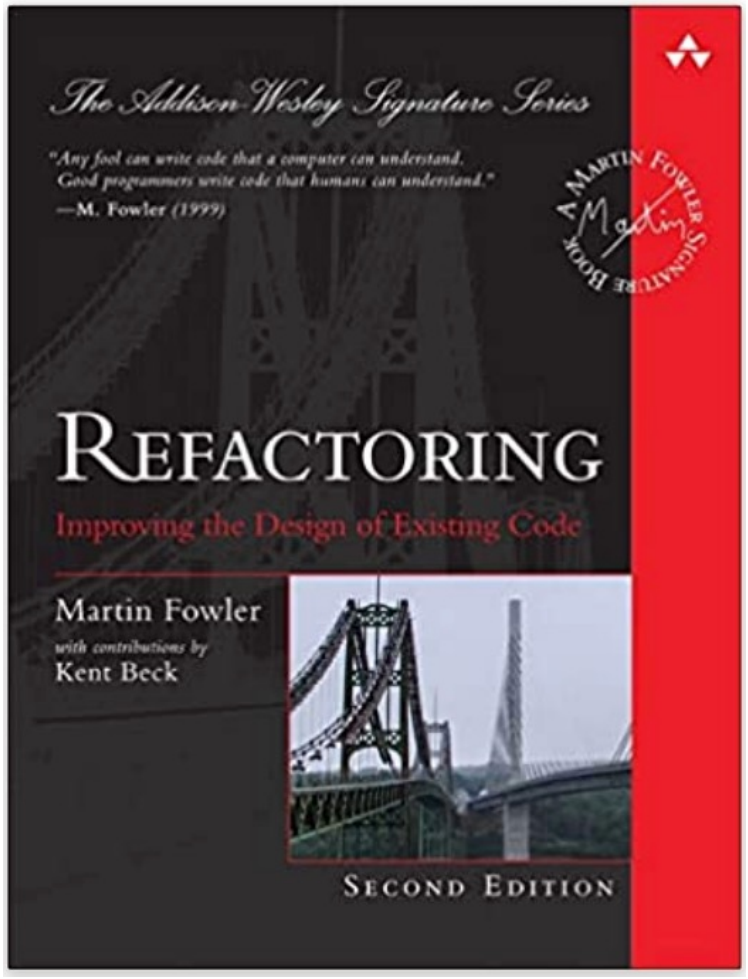
Further Info

Further Infos I

- https://www.ibm.com/developerworks/library/os-eclipse-refactoring/index.html
- https://www.jetbrains.com/help/idea/tutorial-introduction-to-refactoring.html#5db90

- https://refactoring.guru/refactoring
- http://www.tutego.de/java/refactoring/catalog/index.html
- https://www.baeldung.com/intellij-refactoring
- https://github.com/lamchau/refactoring-exercise

Further Info II



Thank You