# Tutorial 4
# More on Refactoring

How to refactoring unstructured code?

How to apply refactoring in Eclipse?

# Last lecture…
# On refactoring

- We explained what is refactoring, what is software refactoring
- How are they related to other restructuring techniques?
- Examples of refactoring
- Refactoring structured source code into goal models
- …

# Today…

1. How to refactoring unstructured code into goal models?
2. How to use Eclipse to do refactoring?
3. Discussions
4. Relation to your course project

# 1. Refactoring an unstructured program

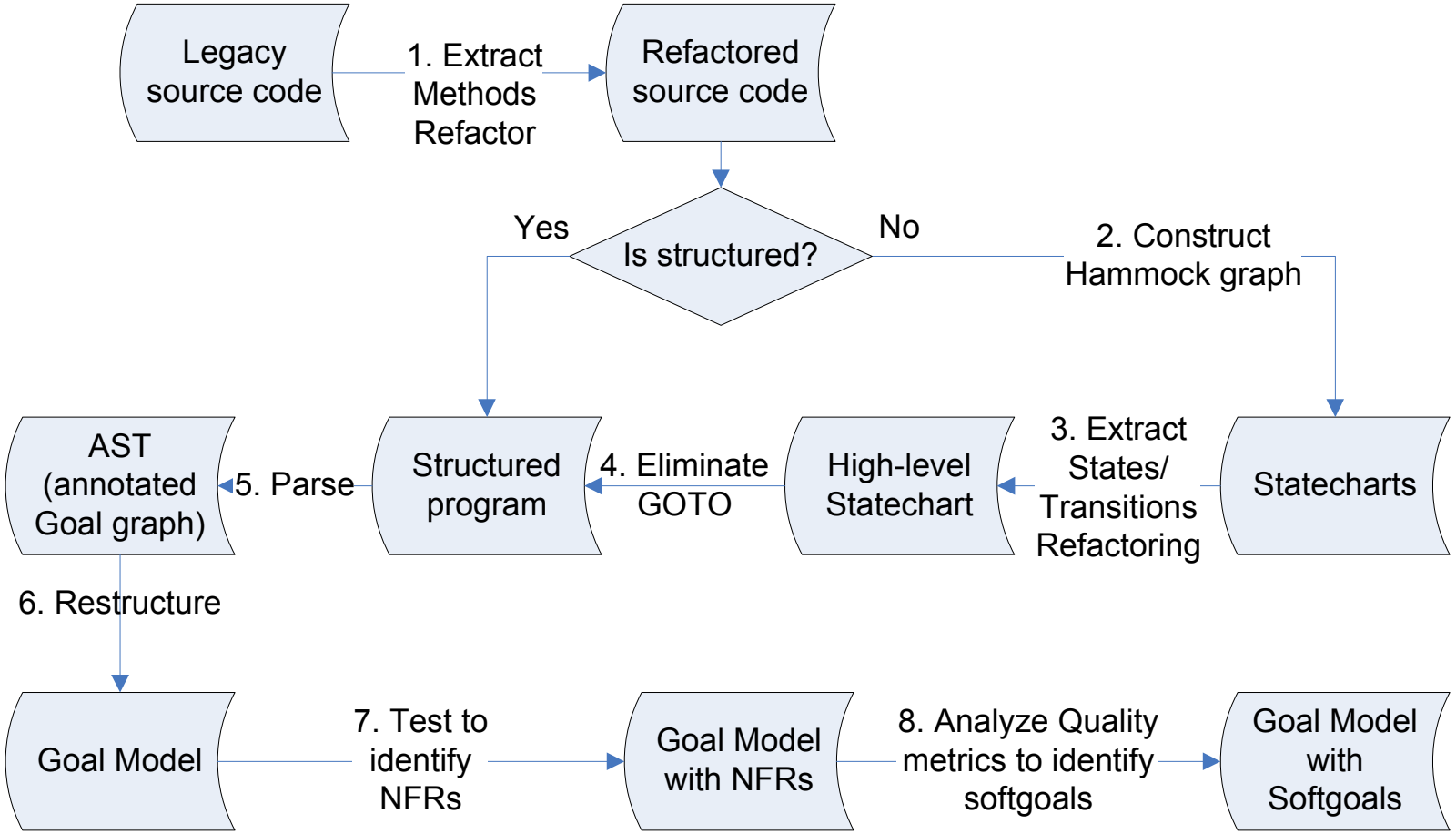
- The subject is called “Squirrel Mail”
- It has 70 KLOC
- Developed in PHP
  Function call
  Foo.php: <?php include(“bar.php”) ?>
- Why it is unstructured?
  Foo.php: <a href=“bar.php”/>
  <a href=“moo.php”/>
  <?php echo “I won super 7!” ?>
  Any idea?

# Why a PHP program is unstructured?

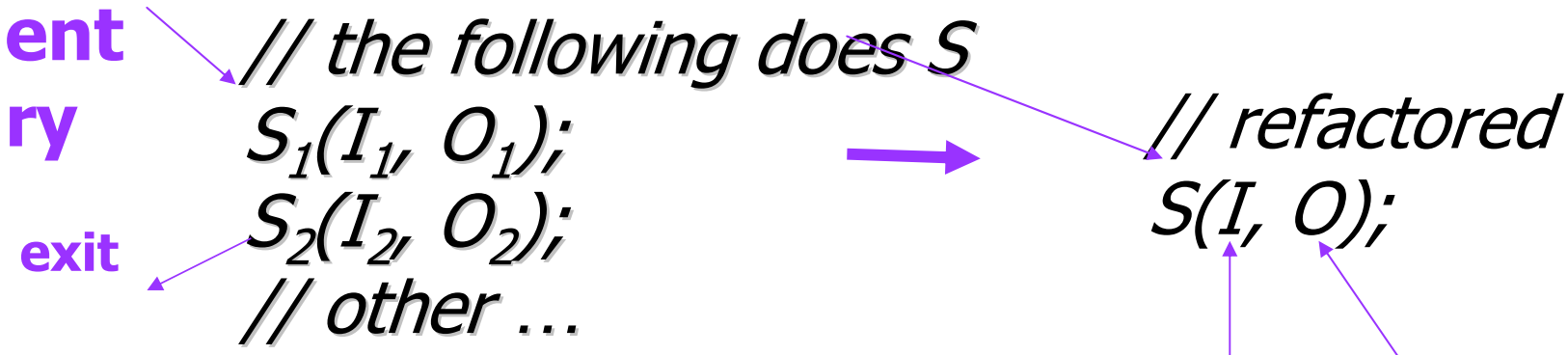
- Every Hyperlink generated from the PHP is an “exit” in the current PHP program
- It may call other PHP routines, other web pages, etc. when user click at them
- Non-deterministic, how could you tell which link will the user click?
- Even “go back” button will change the behaviour of the program
- So …

# The process

- Structured program is easier to understand



# 1.1 Refactoring based on comments




*Variables defined before the entry of the block*

$$I = (I_1 \cup I_2) \cap \{ v \mid def(v, p) \wedge p \angle p_{entry} \} \neq \phi$$

*Variables defined in the block that will be used after the exit*

$$O = (O_1 \cup O_2) \cap \{ v \mid use(v, p) \wedge p_{exit} \angle p \} \neq \phi$$

# Example

```
/** Path for SquirrelMail required files. */
define('SM_PATH','../');
require_once($SM_PATH . 'functions/strings.php');
require_once($SM_PATH . 'config/config.php');
require_once($SM_PATH . 'functions/i18n.php');
require_once($SM_PATH . 'functions/plugin.php');
require_once($SM_PATH . 'functions/constants.php');
require_once($SM_PATH . 'functions/page_header.php');
require_once($SM_PATH . 'functions/html.php');
require_once($SM_PATH . 'functions/global.php');
require_once($SM_PATH . 'functions/imap_general.php');
```

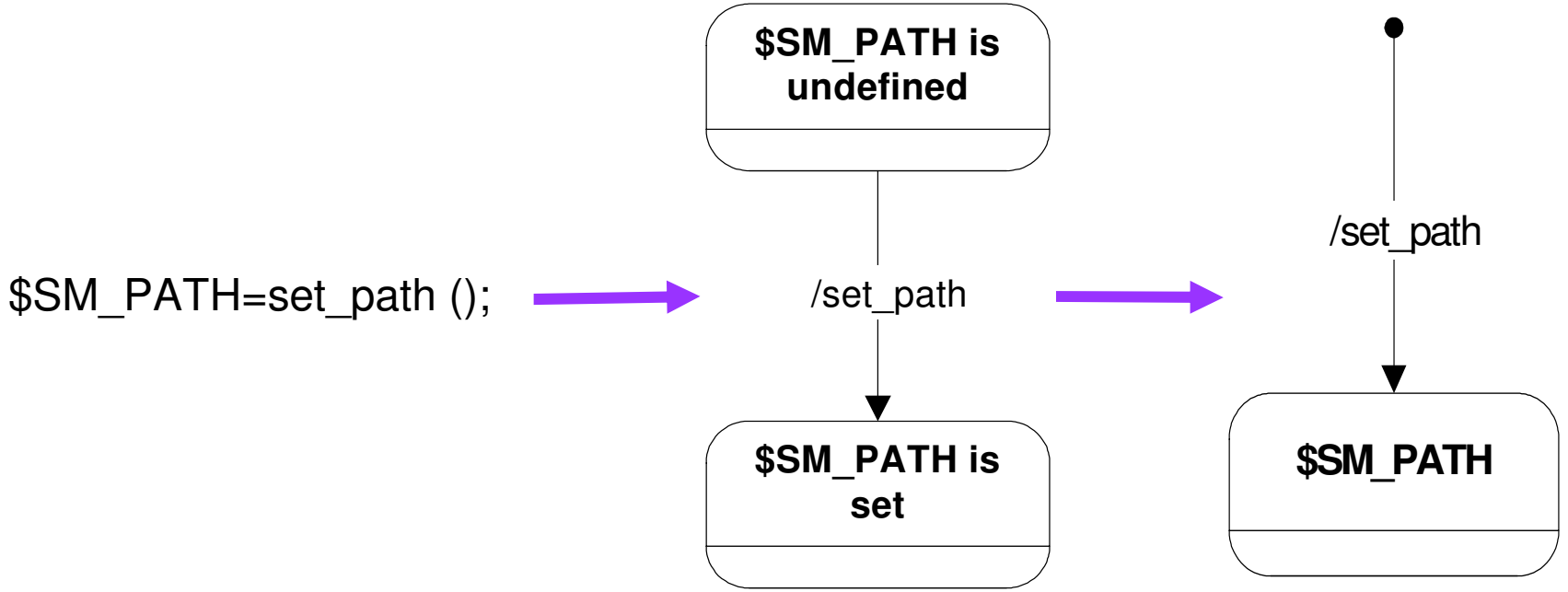
```
$SM_PATH=set_path ();
```

# Further …

```
<?php /* login.php */
$SM_PATH=set_path ();
$SM_lang=setup_language();
$base_uri  = findout_base_URI();
$logindisabled = detect_imap_server($base_uri);
if ($logindisabled) {
    explain_situation();
    exit;
}
do_hook(‘login_cookie’);
$header =onload_function(“redirect.php”);
display_header($header);
load_theme($theme[$theme_default]);
do_hook('login_top');
show_logo();
show_form($loginname, $mailto, $key);
do_hook('login_form');
do_hook('login_bottom');
?>
```

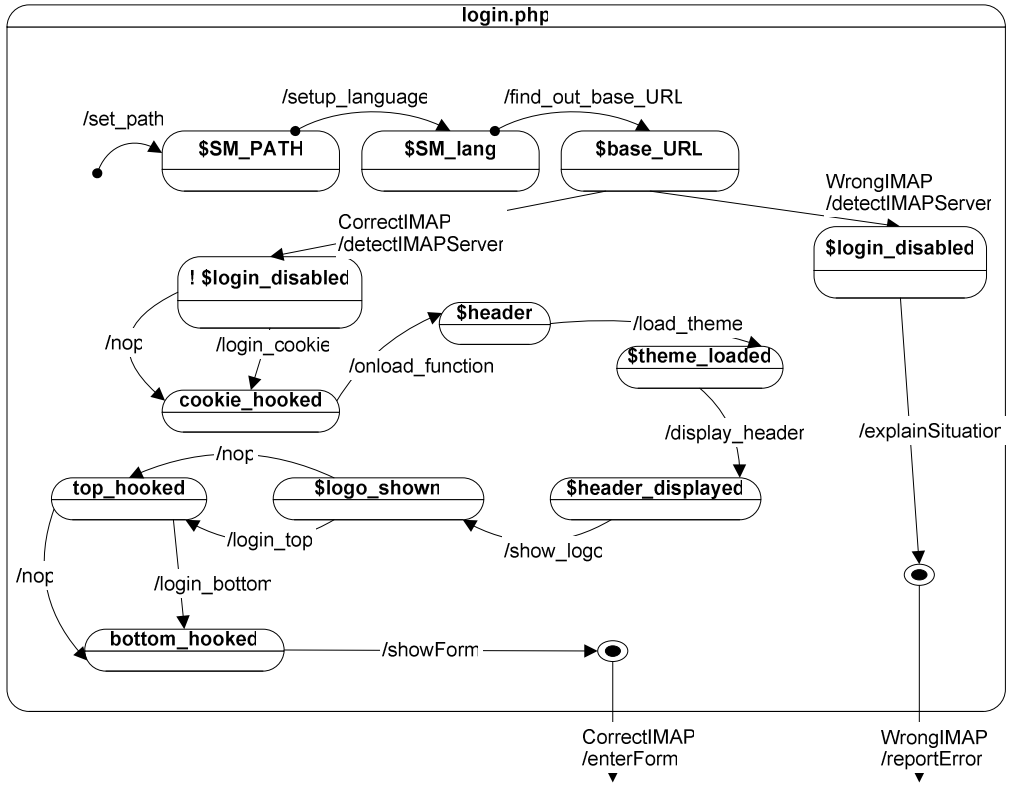
# 1.2 Convert into statechart

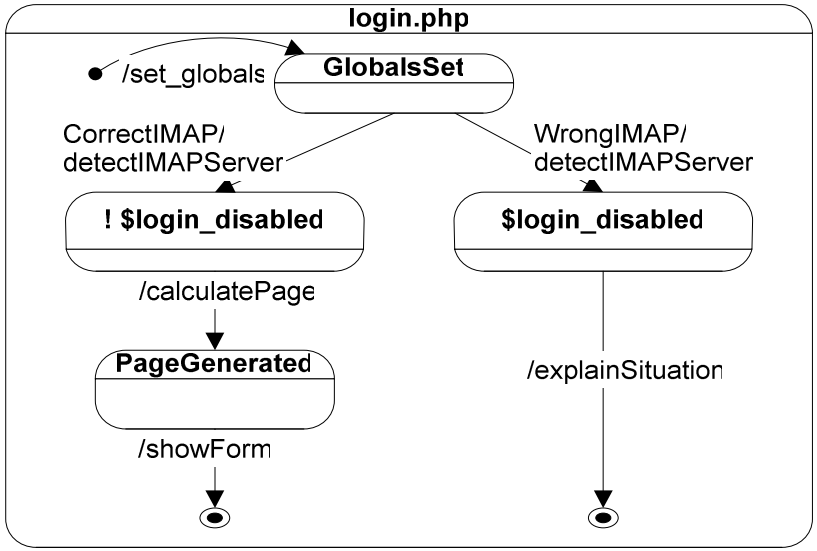
- Statecharts concisely describe behaviour of a system.
- No comments now, but we need to understand its behaviour, therefore …



# 1.3 Statechart refactoring

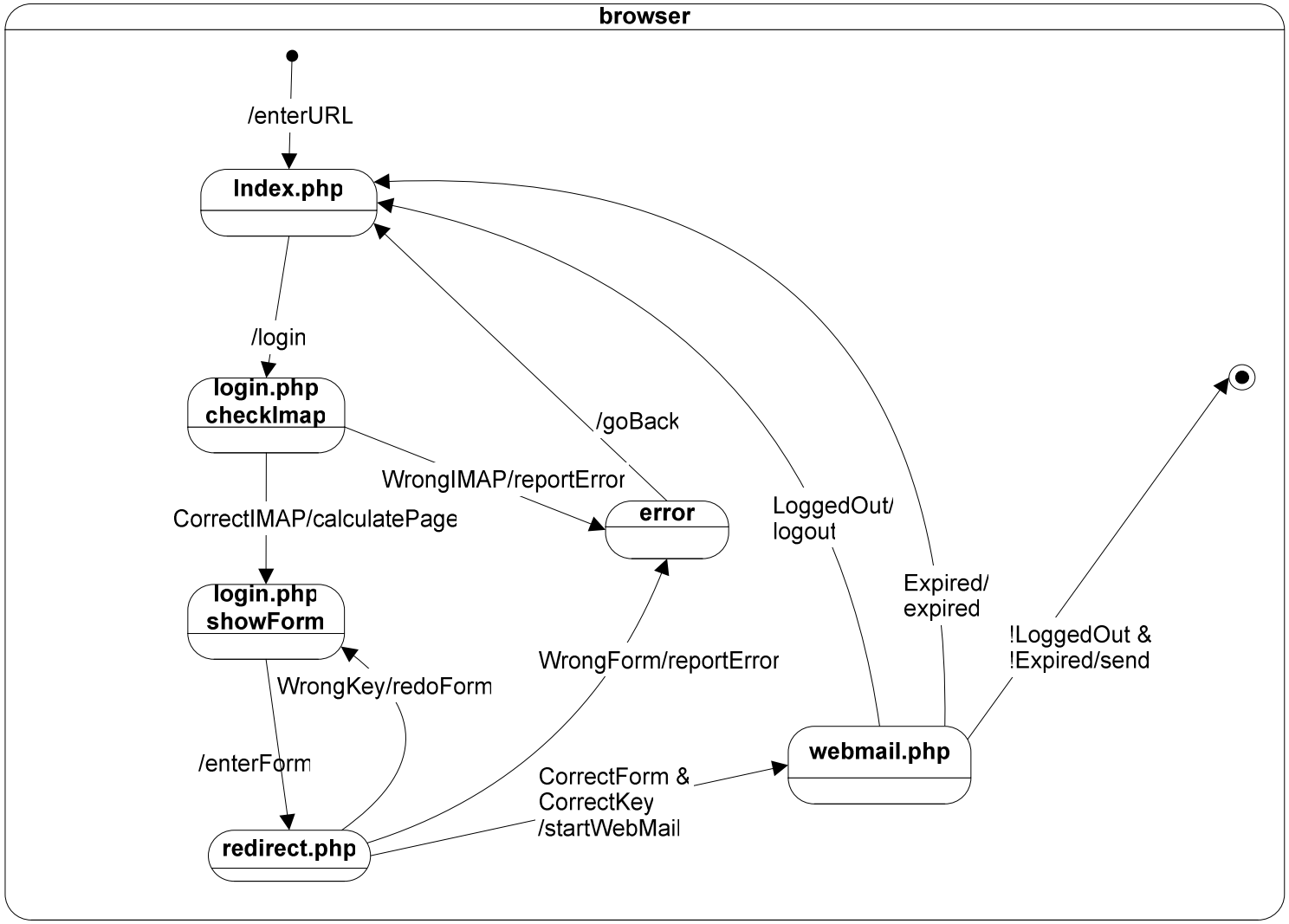
Extract Method -> Extract States and Transitions based on Hammock graphs




What's new here? You are refactoring behaviour rather than structures!

# 1.4 Put it together …the high-level statechart of the unstructured program



# 1.4 Now convert statechart back into a program with GOTO's

- FORTRAN

```
      call EnterURL
10    call Login
      if (wrongIMAP) goto 30
20    call ShowForm
      if (wrongKey) goto 20
      call EnterForm
      if (wrongForm) goto 30
      call StartWebMail
      if (loggedOut) goto 10
      if (expired) goto 10
      call Send
      Stop
30    call ReportError
      call GoBack
      goto 10
      end
```

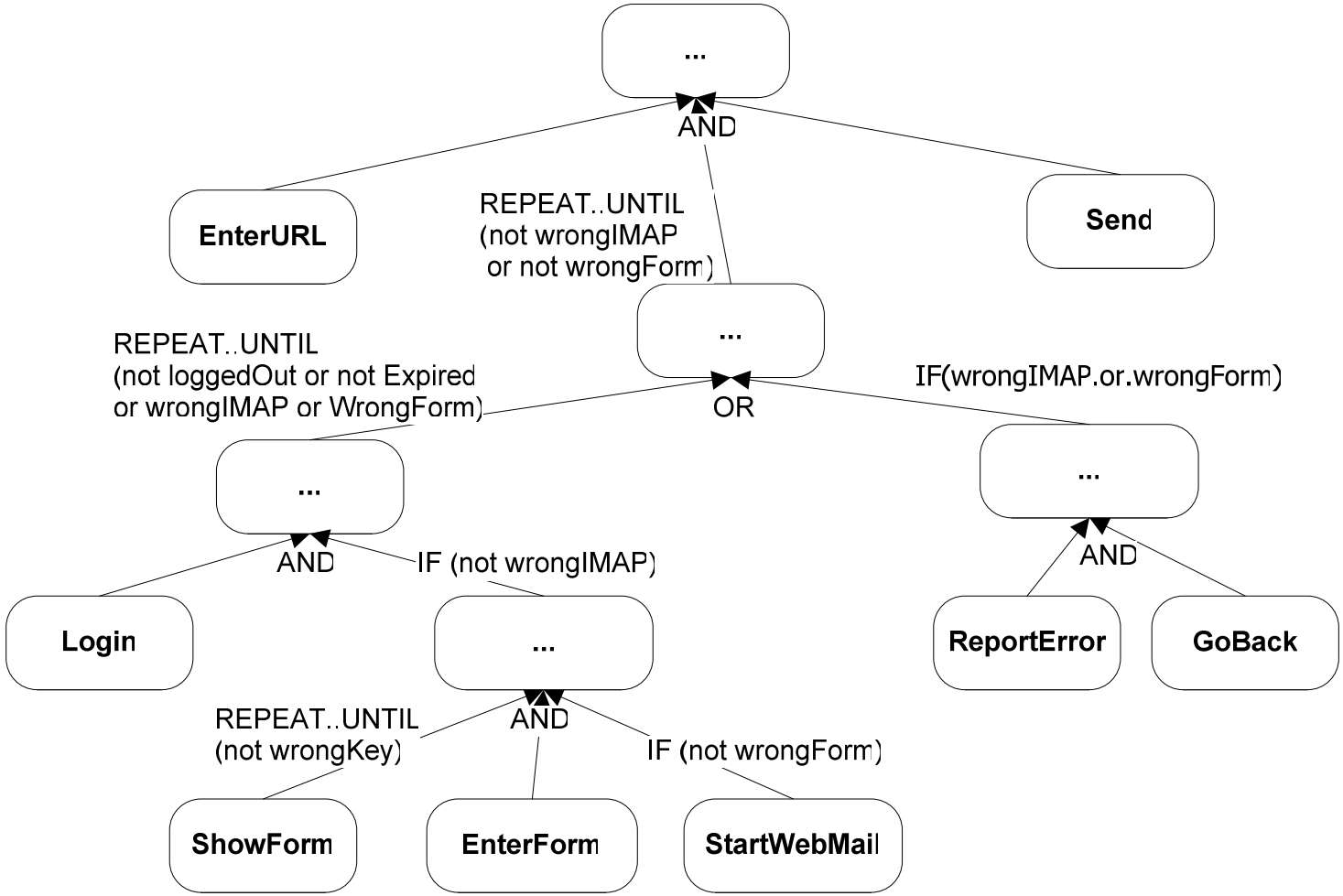
- Rule of thumb: every state is a basic block; adding a label to states with multiple incoming transitions; adding GOTO statements for all outgoing transitions except one; line-up the basic blocks

# 1.4 Eliminate GOTO's

- FPT (Fortran parallelizing transformer, developed at ELIS, Ghent University, Belgium)
- Result of goto elimination:

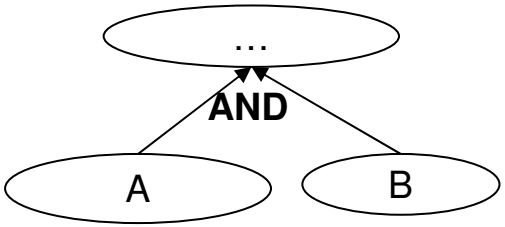
```
CALL EnterURL
REPEAT
REPEAT
  CALL Login
   IF (.not.wrongIMAP) THEN
     REPEAT
        CALL ShowForm
     UNTIL (.not.wrongKey)
     CALL EnterForm
     IF(.not.wrongForm)THEN
       CALL StartWebmail
     ENDIF
         ENDIF
UNTIL (.not.loggedOut.or .not.expired.or.wrongIMAP .or.wrongForm)
IF(wrongIMAP.or.wrongForm)
THEN
   CALL ReportError
   CALL GoBack
       ENDIF
UNTIL (.not.wrongIMAP.and.not.wrongForm)
CALL Send
END
```

# 1.5 Turning structured program into an annotated goal model

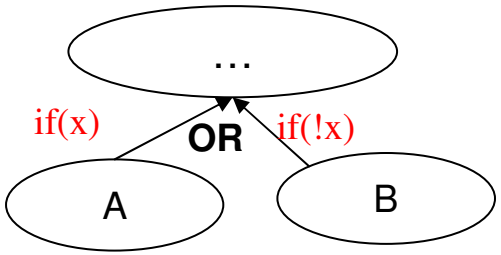


# 1.6 Turning it into “pure” goal model (AND/OR graph)

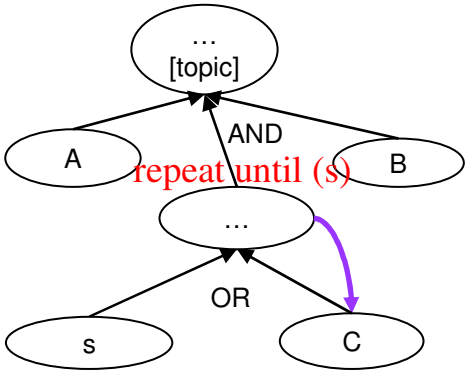
•call A
call B

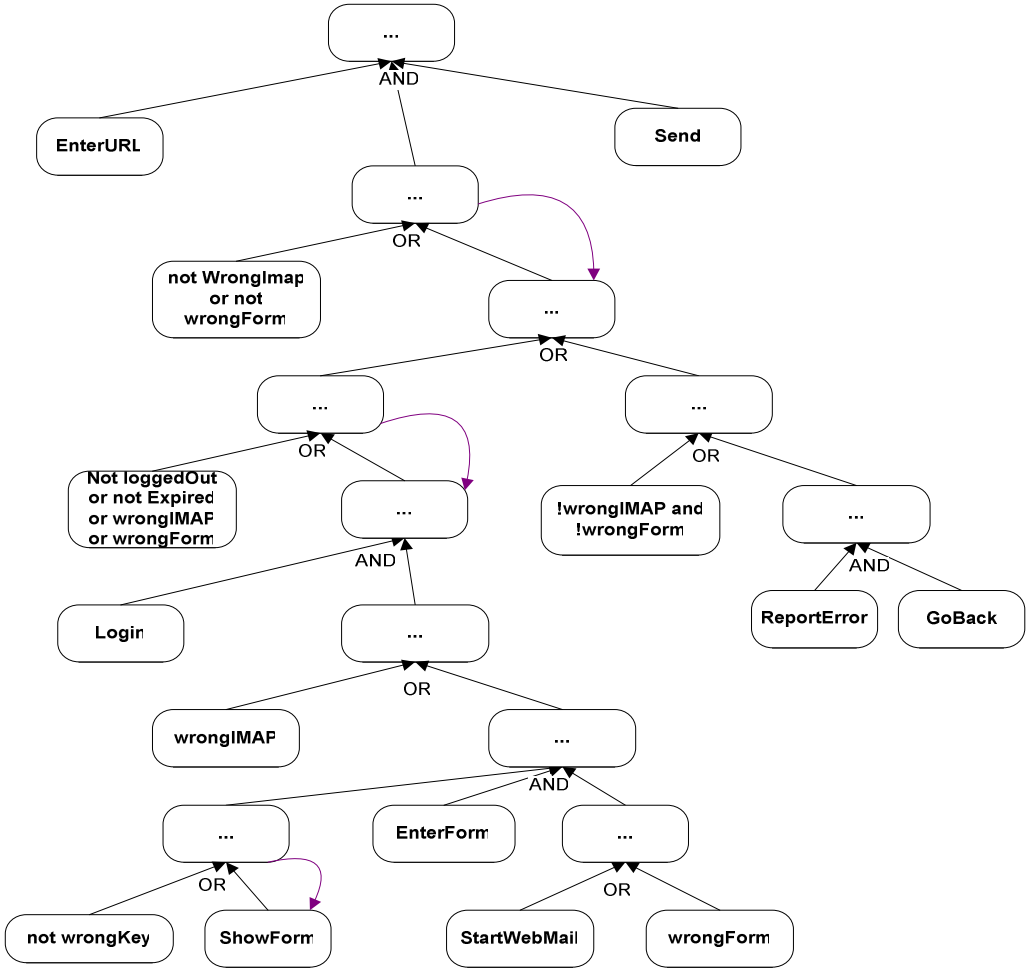



•if (x) then
call A
else
call B
end if



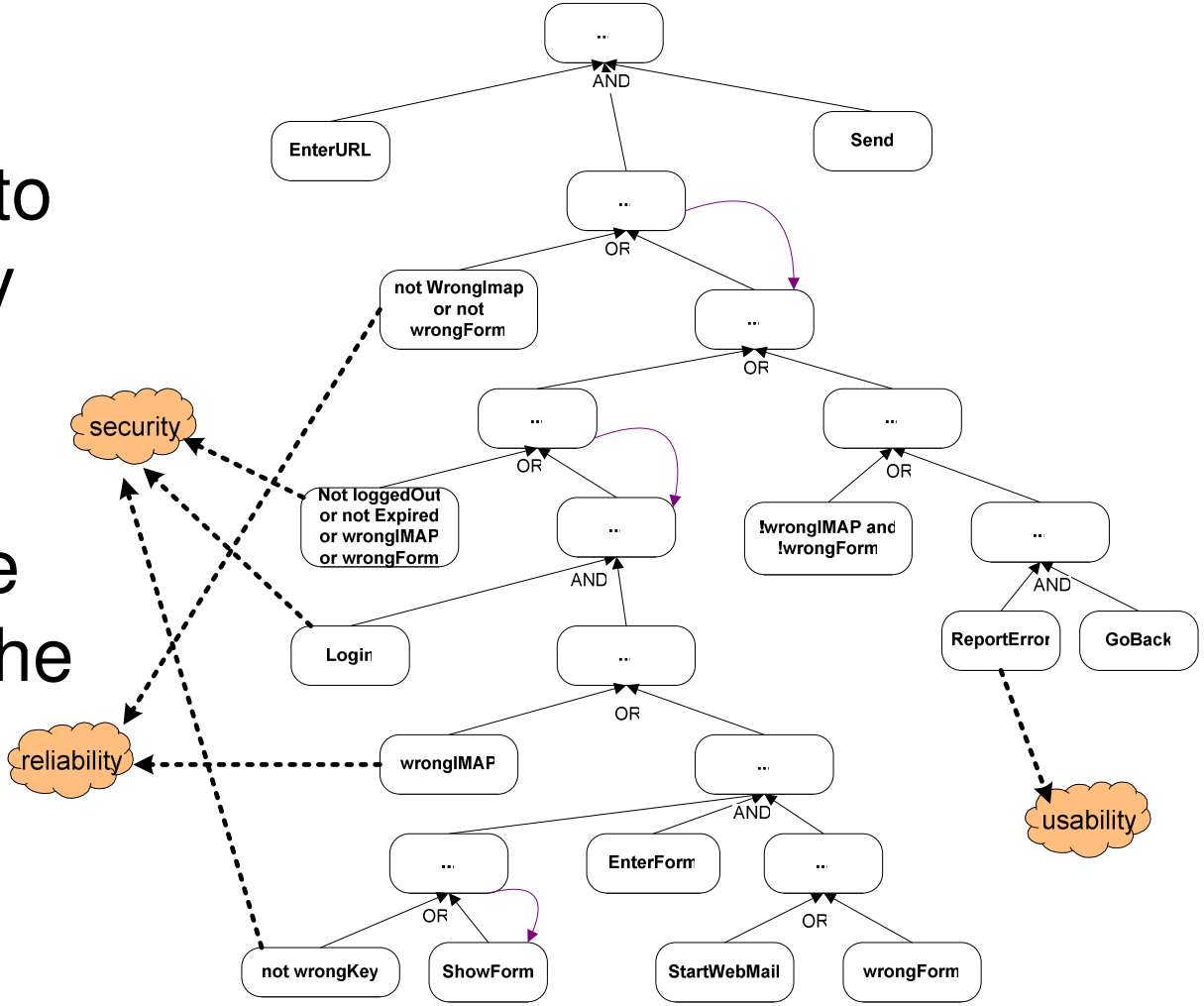

•call A
repeat
call C
until s
call B



# 1.7 Introducing softgoals

- Identify NFRs
- Add softgoals to categorize why there are the NFRs
- If possible, one can measure the degree of satisfaction for the softgoals



# 2. How to refactoring in Eclipse

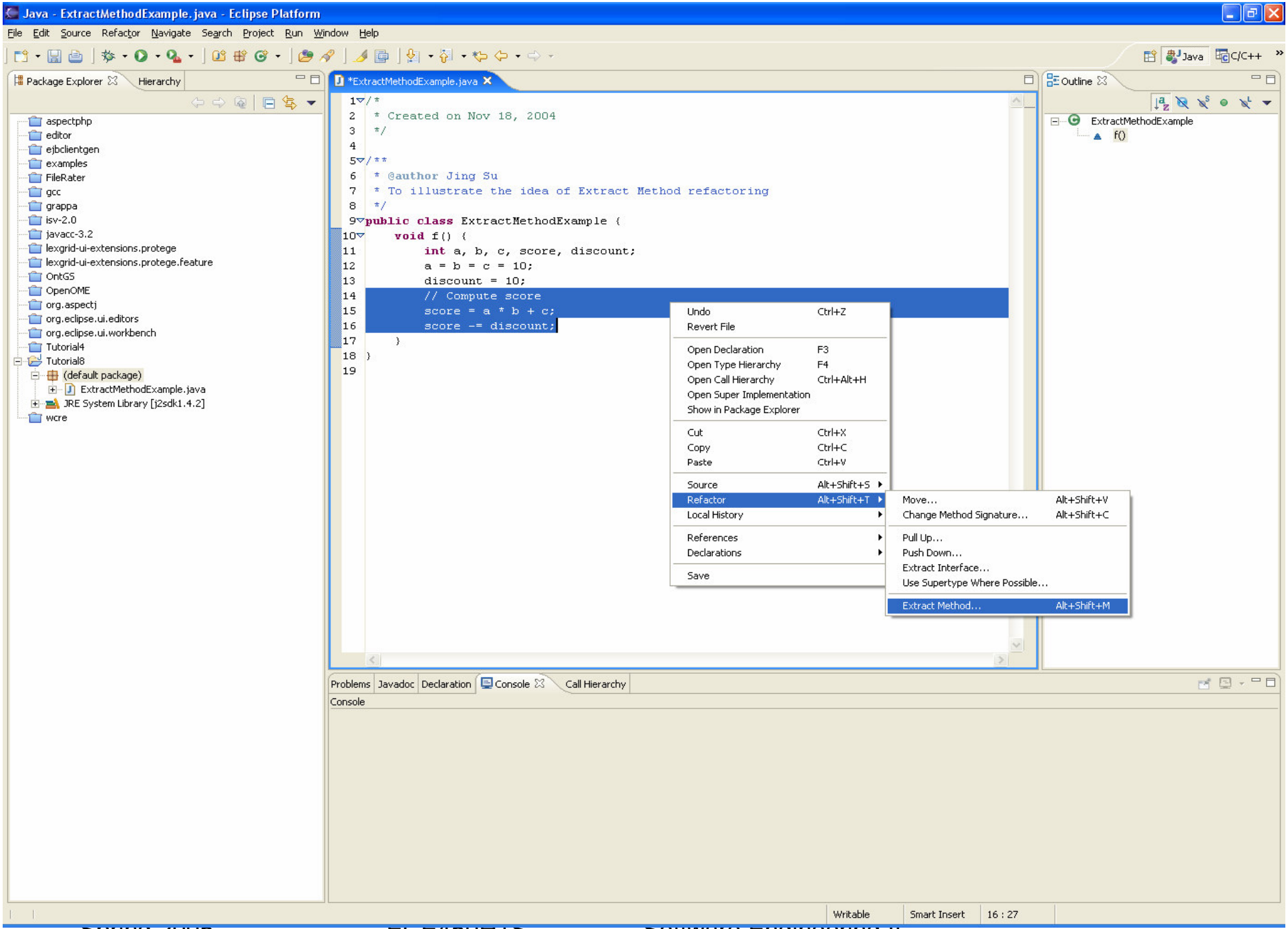
- If you are developing in Java, you are LUCKY!
- The Eclipse IDE, JBuilder IDE are very comprehensive
- Refactoring was developed in Smalltalk, now moved to Java in Eclipse, it has been told in C# for Visual Studio, etc.
- It should not be long to see open-source programming languages to have them supported, such as PHP
- Examples, developed by Jing Su

# Example 1 – extract method

```
void f() {
    ...
    // Compute score
    score = a * b + c;
    score -= discount;
}
```

```
void f() {
    ...
    computeScore();
}

void computeScore() {
    score = a * b + c;
    score -= discount;
}
```


Java - ExtractMethodExample.java - Eclipse Platform
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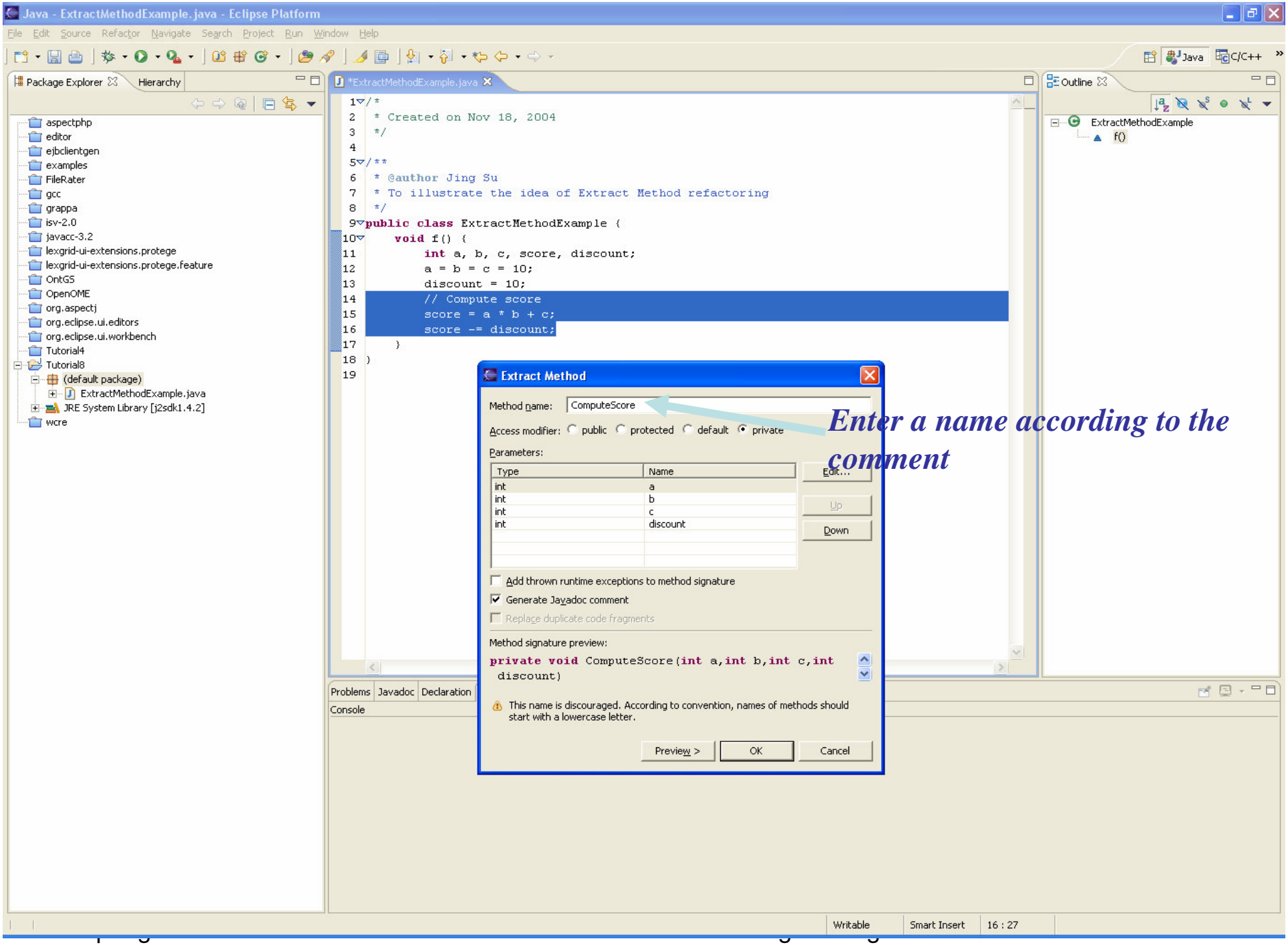
Tutorial4
Tutorial8
(default package)
ExtractMethodExample.java
JRE System Library [j2sdk1.4.2]
wcre
*ExtractMethodExample.java
1 /*
2 * Created on Nov 18, 2004
3 */
4
5 /**
6 * @author Jing Su
7 * To illustrate the idea of Extract Method refactoring
8 */
9 public class ExtractMethodExample {
10 void f() {
11 int a, b, c, score, discount;
12 a = b = c = 10;
13 discount = 10;
14 // Compute score
15 score = a * b + c;
16 score -= discount;
17 }
18 }
19
Undo Ctrl+Z
Revert File
Open Declaration F3
Open Type Hierarchy F4
Open Call Hierarchy Ctrl+Alt+H
Open Super Implementation
Show in Package Explorer
Cut Ctrl+X
Copy Ctrl+C
Paste Ctrl+V
Source Alt+Shift+S
Refactor Alt+Shift+T
Local History
References
Declarations
Save
Move... Alt+Shift+V
Change Method Signature... Alt+Shift+C
Pull Up...
Push Down...
Extract Interface...
Use Supertype Where Possible...
Extract Method... Alt+Shift+M
Outline
ExtractMethodExample
f()
Problems Javadoc Declaration Console Call Hierarchy
Console
Writable Smart Insert 16 : 27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11 int a, b, c, score, discount;
12 a = b = c = 10;
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14 // Compute score
15 score = a * b + c;
16 score -= discount;
17 }
18 }
19
Outline
ExtractMethodExample
f()
Extract Method
Method name: ComputeScore
Access modifier: public protected default private
Parameters:
Type Name
int a
int b
int c
int discount
Edit...
Up
Down
Add thrown runtime exceptions to method signature
Generate Javadoc comment
Replace duplicate code fragments
Method signature preview:
private void ComputeScore(int a,int b,int c,int discount)
This name is discouraged. According to convention, names of methods should start with a lowercase letter.
Preview >
OK
Cancel
Enter a name according to the comment
Problems Javadoc Declaration
Console
Writable
Smart Insert
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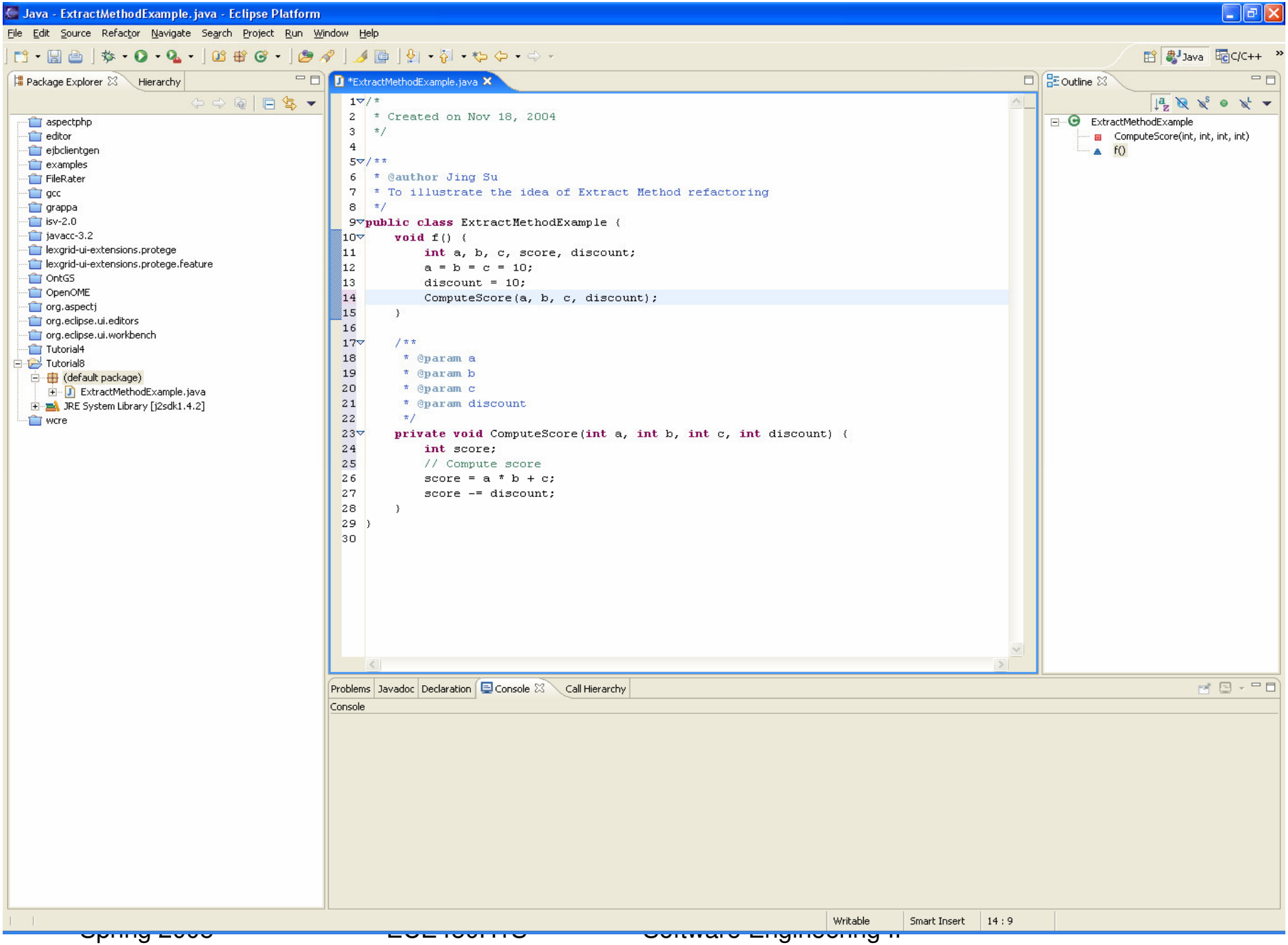
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5 /**
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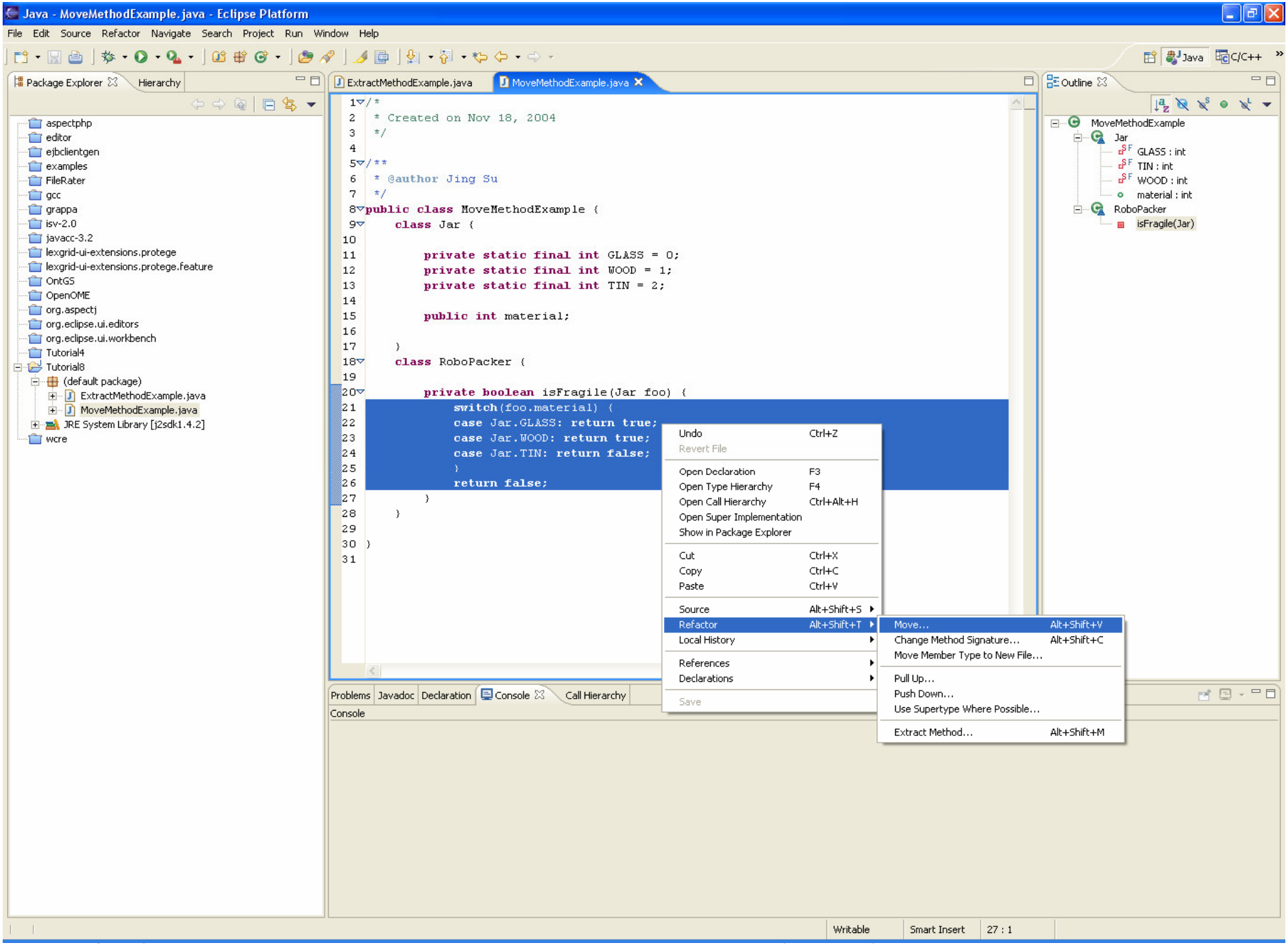
7 * To illustrate the idea of Extract Method refactoring
8 */
9 public class ExtractMethodExample {
10 void f() {
11 int a, b, c, score, discount;
12 a = b = c = 10;
13 discount = 10;
14 ComputeScore(a, b, c, discount);
15 }
16
17 /**
18 * @param a
19 * @param b
20 * @param c
21 * @param discount
22 */
23 private void ComputeScore(int a, int b, int c, int discount) {
24 int score;
25 // Compute score
26 score = a * b + c;
27 score -= discount;
28 }
29 }
30
Outline
ExtractMethodExample
ComputeScore(int, int, int, int)
f()
Problems Javadoc Declaration Console Call Hierarchy
Console
Writable Smart Insert 14 : 9

# Example 2 – move method

```
class Jar {
    ...
}
class RoboPacker {
    private bool isFragile(Jar foo) {
        switch(foo.material) {
        case GLASS: return true;
        case WOOD: return true;
        case TIN: return false;
        }
    }
}
```

```
class Jar {
    bool isFragile() {
        switch(material) {
        case GLASS: return true;
        case WOOD: return true;
        case TIN: return false;
} } }
class RoboPacker {
    private bool isFragile(Jar foo) {
        return foo.isFragile();
    }
}
```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MoveMethodExample.java
JRE System Library [j2sdk1.4.2]
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ExtractMethodExample.java
MoveMethodExample.java
1 /*
2 * Created on Nov 18, 2004
3 */
4
5 /**
6 * @author Jing Su
7 */
8 public class MoveMethodExample {
9 class Jar {
10
11 private static final int GLASS = 0;
12 private static final int WOOD = 1;
13 private static final int TIN = 2;
14
15 public int material;
16
17 }
18 class RoboPacker {
19
20 private boolean isFragile(Jar foo) {
21 switch(foo.material) {
22 case Jar.GLASS: return true;
23 case Jar.WOOD: return true;
24 case Jar.TIN: return false;
25 }
26 return false;
27 }
28 }
29
30 }
31
Undo Ctrl+Z
Revert File
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Refactor Alt+Shift+T
Local History
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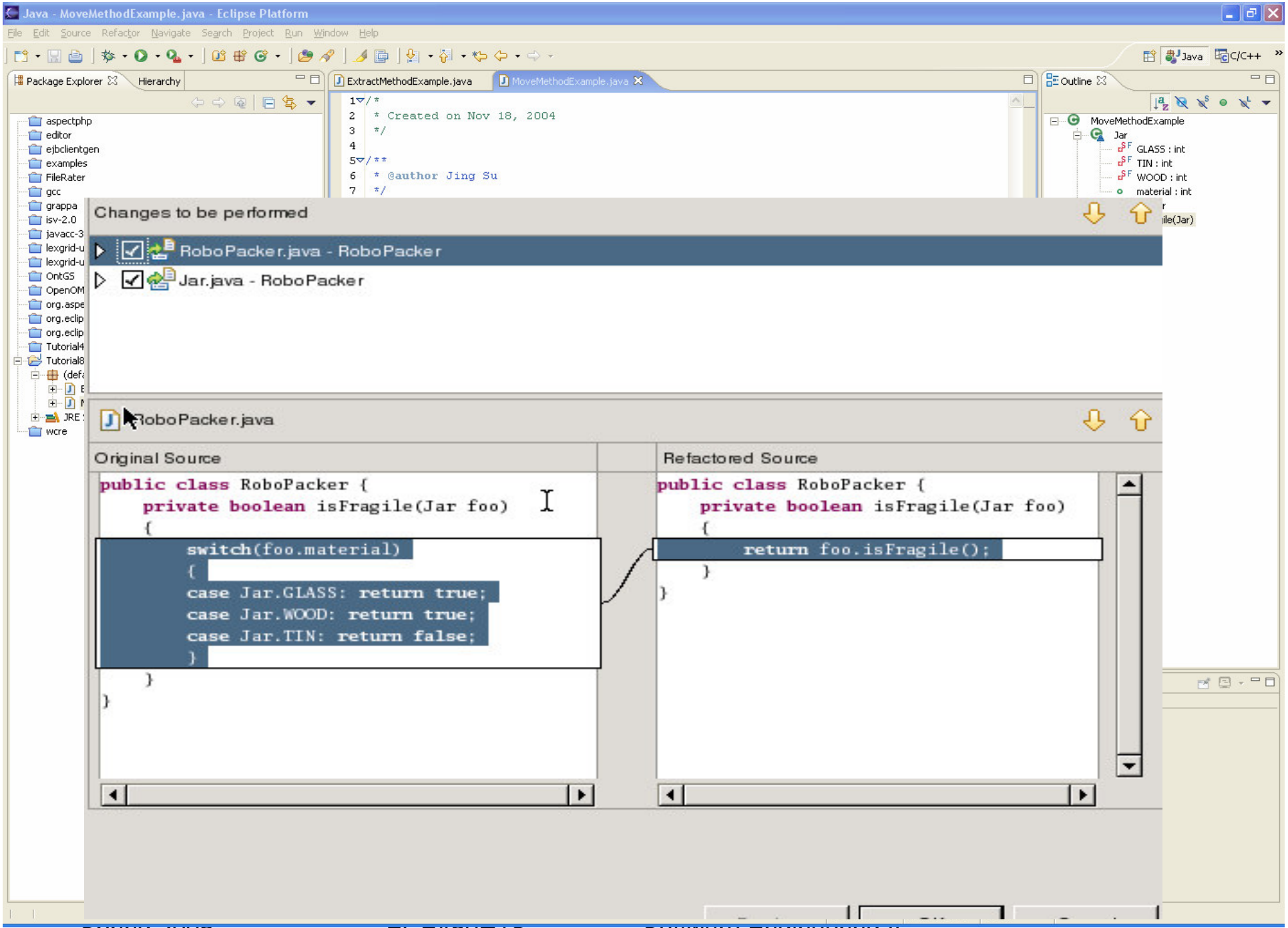
Declarations
Save
Move... Alt+Shift+V
Change Method Signature... Alt+Shift+C
Move Member Type to New File...
Pull Up...
Push Down...
Use Supertype Where Possible...
Extract Method... Alt+Shift+M
Outline
MoveMethodExample
Jar
GLASS : int
TIN : int
WOOD : int
material : int
RoboPacker
isFragile(Jar)
Problems Javadoc Declaration Console Call Hierarchy
Console
Writable
Smart Insert
27 : 1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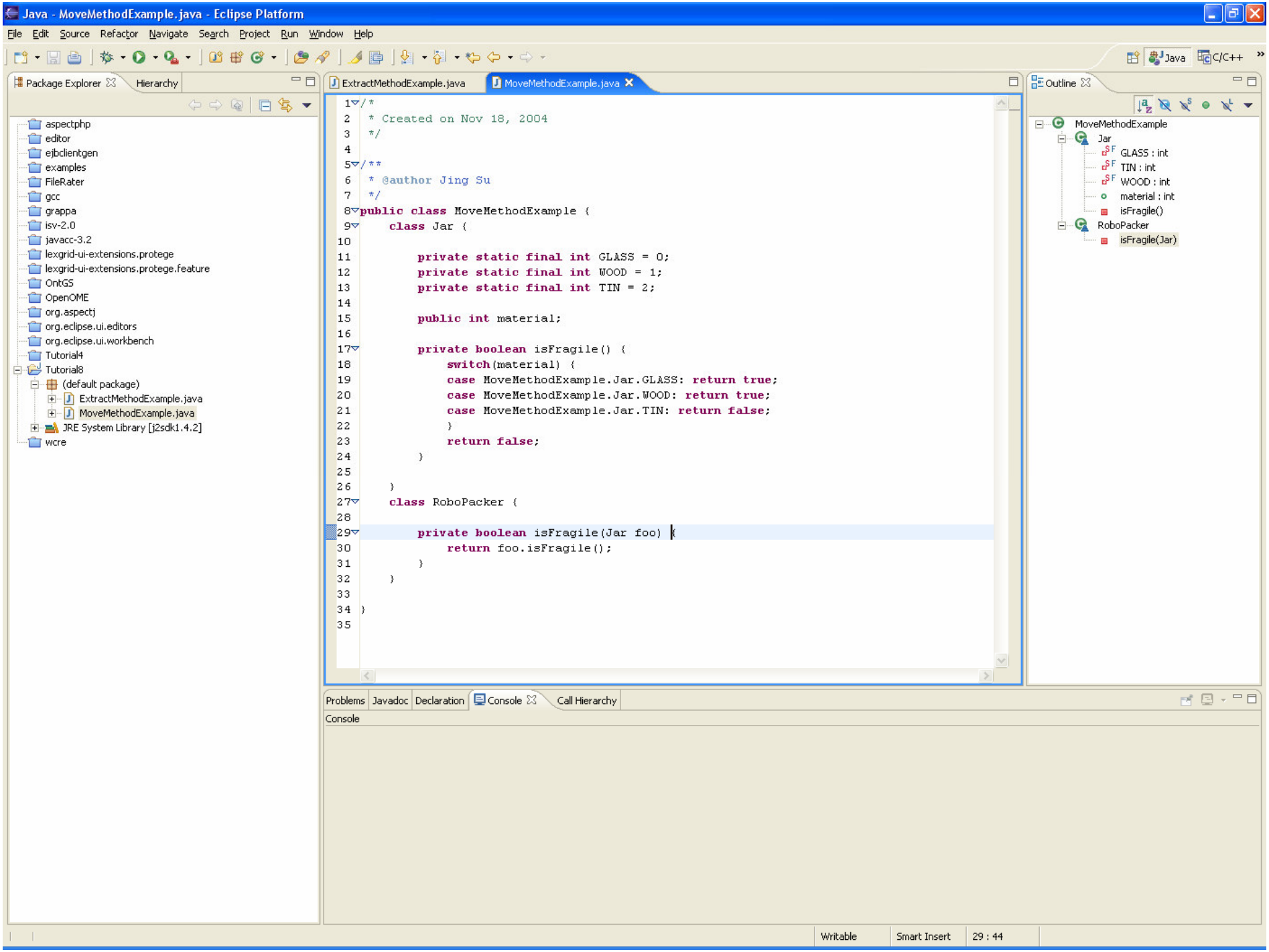
MoveMethodExample.java
Outline
MoveMethodExample
Jar
GLASS : int
TIN : int
WOOD : int
material : int
Changes to be performed
RoboPacker.java - RoboPacker
Jar.java - RoboPacker
RoboPacker.java
Original Source
Refactored Source
public class RoboPacker {
private boolean isFragile(Jar foo)
{
switch(foo.material)
{
case Jar.GLASS: return true;
case Jar.WOOD: return true;
case Jar.TIN: return false;
}
}
}
public class RoboPacker {
private boolean isFragile(Jar foo)
{
return foo.isFragile();
}
}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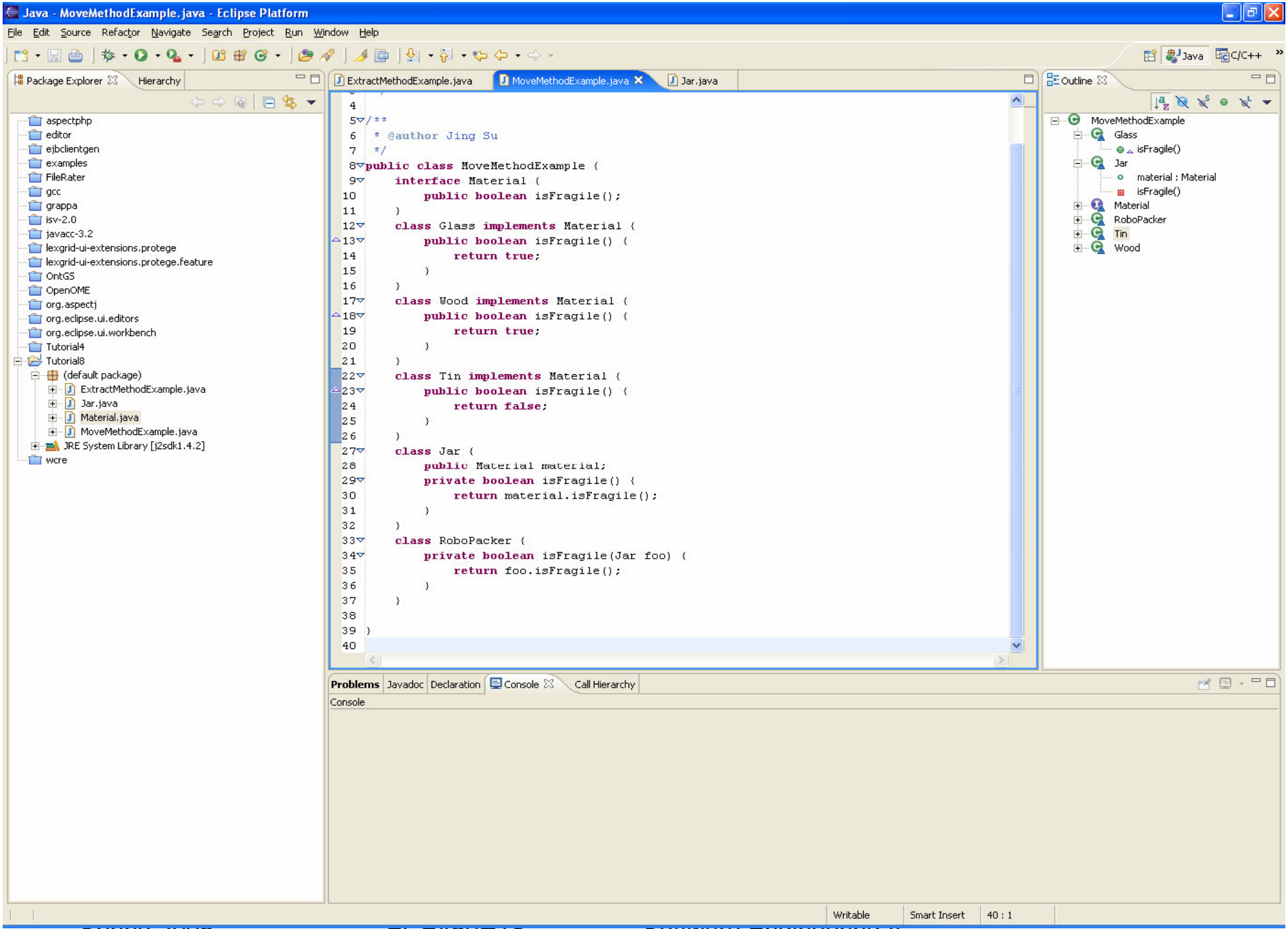
3 */
4
5 /**
6 * @author Jing Su
7 */
8 public class MoveMethodExample {
9 class Jar {
10
11 private static final int GLASS = 0;
12 private static final int WOOD = 1;
13 private static final int TIN = 2;
14
15 public int material;
16
17 private boolean isFragile() {
18 switch(material) {
19 case MoveMethodExample.Jar.GLASS: return true;
20 case MoveMethodExample.Jar.WOOD: return true;
21 case MoveMethodExample.Jar.TIN: return false;
22 }
23 return false;
24 }
25
26 }
27 class RoboPacker {
28
29 private boolean isFragile(Jar foo) {
30 return foo.isFragile();
31 }
32 }
33
34 }
35
Outline
MoveMethodExample
Jar
GLASS : int
TIN : int
WOOD : int
material : int
isFragile()
RoboPacker
isFragile(Jar)
Problems Javadoc Declaration Console Call Hierarchy
Console
Writable
Smart Insert
29 : 44

# Example 3 – lift method

```
class Jar {
    bool isFragile() {
        switch(material) {
        case GLASS:
            // complex glass calculation
        case WOOD:
            // complex wood calculation
        case TIN:
            // complex tin calculation
} } }
```

```
class Jar {
    bool isFragile() {
        return material.isFragile();
} }

interface Material { ... }
class GlassMaterial:Material { ... }
class WoodMaterial:Material { ... }
class TinMaterial:Material { ... }
```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Jar.java
Material.java
MoveMethodExample.java
JRE System Library [j2sdk1.4.2]
wcre
ExtractMethodExample.java
MoveMethodExample.java
Jar.java
4
5 /**
6 * @author Jing Su
7 */
8 public class MoveMethodExample {
9 interface Material {
10 public boolean isFragile();
11 }
12 class Glass implements Material {
13 public boolean isFragile() {
14 return true;
15 }
16 }
17 class Wood implements Material {
18 public boolean isFragile() {
19 return true;
20 }
21 }
22 class Tin implements Material {
23 public boolean isFragile() {
24 return false;
25 }
26 }
27 class Jar {
28 public Material material;
29 private boolean isFragile() {
30 return material.isFragile();
31 }
32 }
33 class RoboPacker {
34 private boolean isFragile(Jar foo) {
35 return foo.isFragile();
36 }
37 }
38
39 }
40
Outline
MoveMethodExample
Glass
isFragile()
Jar
material : Material
isFragile()
Material
RoboPacker
Tin
Wood
Problems
Javadoc
Declaration
Console
Call Hierarchy
Console
Writable
Smart Insert
40 : 1

# 3. Think about these …

1. How to extend refactoring tool support to other programming languages such as PHP?
2. Can you extend refactoring to documents, such as in various formats: diagrams, textual, xml, etc.?
3. How can know a function is NFR? Can you measure the impact of a NFR on a quality attribute?

# 4. Relation to your project

- Opportunities:
  - You may add junit test cases to the code base to reveal bugs (publish it to the bug tracking system) and fix them (+5%)
  - *You may apply design patterns, refactoring techniques on this legacy code base, showing as an improved complexity metrics (+2.5%)*
  - You may tune the performance of the system to speed up the display, load/save for scalable graphs (+2.5%)
- Don't forget your major project task (up to 100%!)
  - To study the editor methods in the OpenOME and adapt them to the OmniGraphEditor web service.