Eclipse Code Recommenders

TECHNISCHE UNIVERSITÄT DARMSTADT

IDE 2.0: Eclipse meets Social (and Crowds)

tw: @MarcelBruch
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Eclipse Stammtisch Zurich

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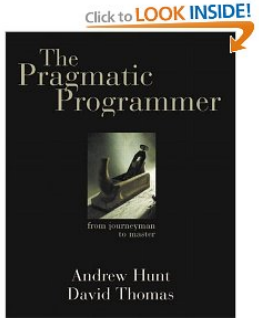

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Andrew Hunt (Author), David Thomas (Author)

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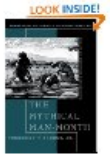

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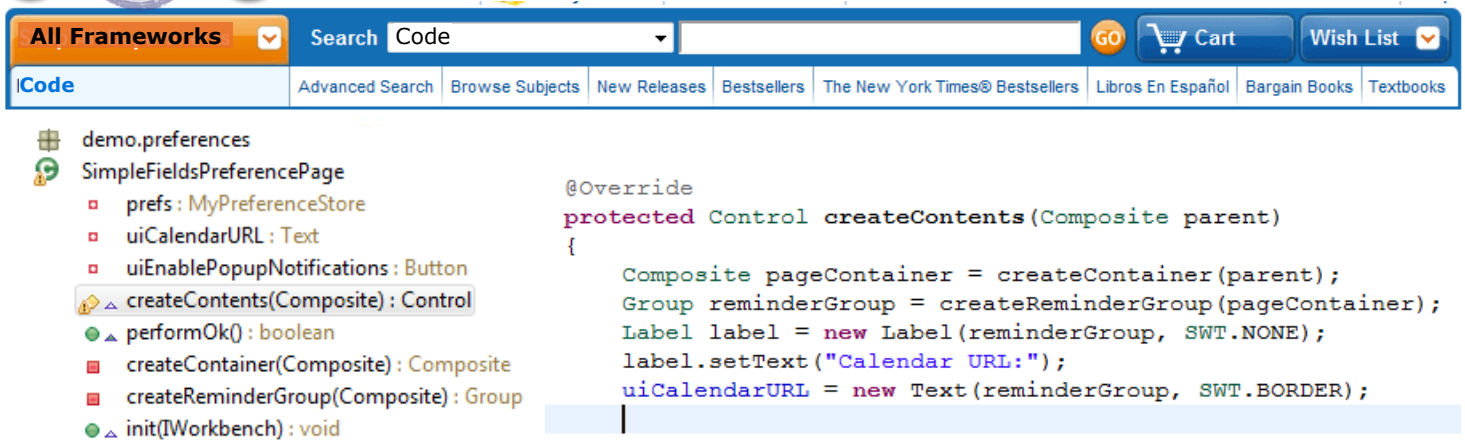
Eclipse Code Recommenders



Developers Who Called "`new Text()`" Method Also Called

setText()	addListener()	setLayout()	setFont()
89%	53%	99%	35%

What Do Developers Ultimately Override After Extending This Class?

100 % overwrote
PreferencePage.createContents()

96 % overwrote
PreferencePage.performOk()

5 % overwrote
PreferencePage.performCancel()

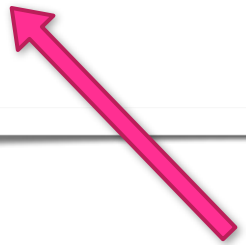
“Other developers frequently ~~bought~~ used the following methods…”

INTELLIGENT CODE COMPLETION

Code Completion…

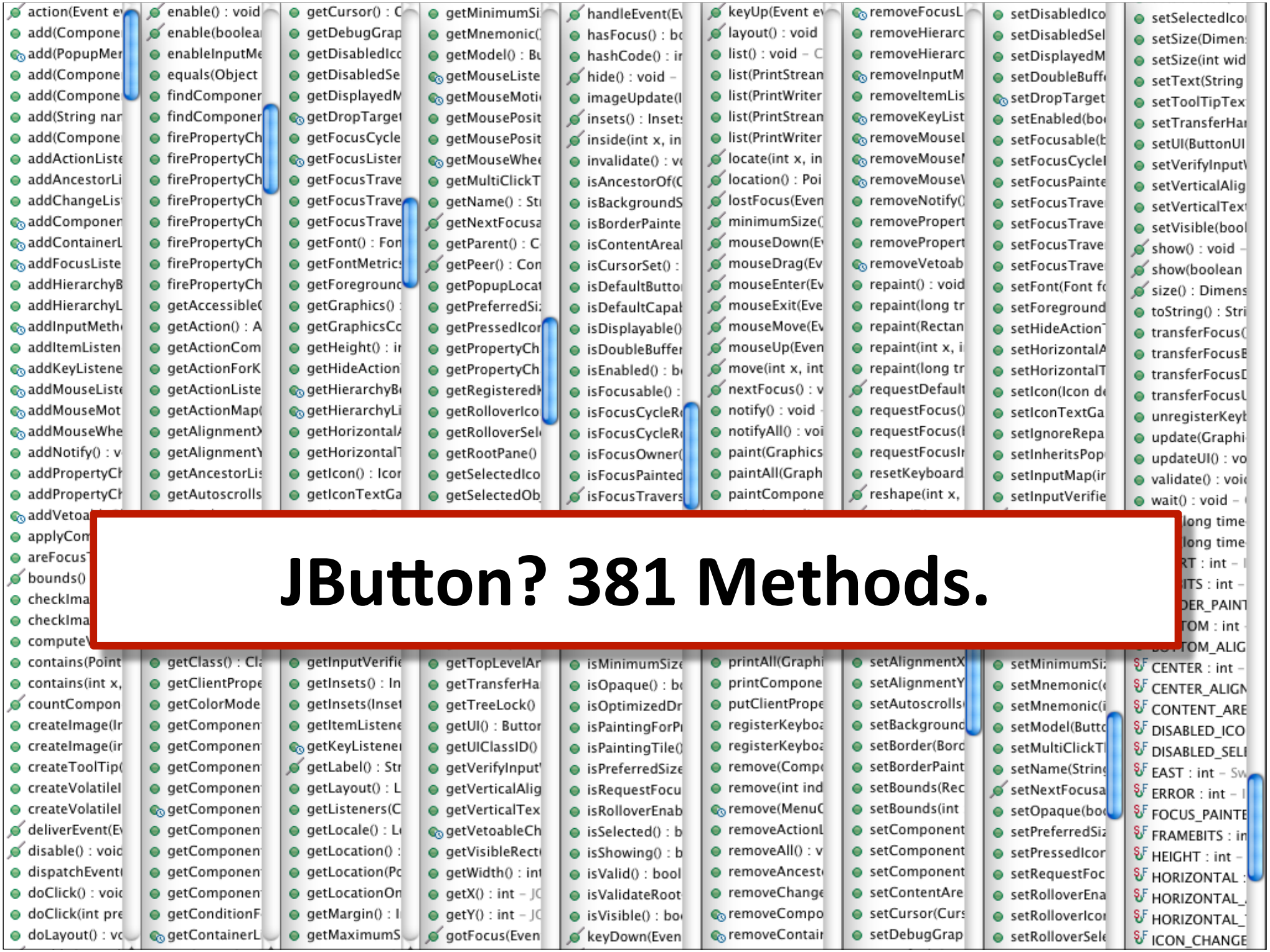
```
@Override
protected Control createDialogArea(final Composite parent) {
    Composite container = (Composite) super.createDialogArea(parent);

    swtTextWidget = new Text(container, SWT.BORDER);
    swtTextWidget.|
    return container;
}
```



What does the developer need, i.e., which methods should the code completion present to the user?

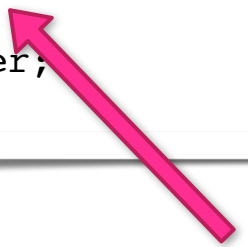
view : NSView – Control
addControlListener(ControlListener listen
addDisposeListener(DisposeListener liste
addDragDetectListener(DragDetectListen
addFocusListener(FocusListener listener)
addHelpListener(HelpListener listener) : v
addKeyListener(KeyListener listener) : voi
addListener(int eventType, Listener listen
addMenuDetectListener(MenuDetectListe
addModifyListener(ModifyListener listene
addMouseListener(MouseListener listener
addMouseMoveListener(MouseMoveLister
addMouseTrackListener(MouseTrackListe
addMouseWheelListener(MouseWheelList
addPaintListener(PaintListener listener) :
addSelectionListener(SelectionListener lis
addTraverseListener(TraverseListener list
addVerifyListener(VerifyListener listener)
append(String string) : void – Text
clearSelection() : void – Text
computeSize(int wHint, int hHint) : Point
computeSize(int wHint, int hHint, boolear
computeTrim(int x, int y, int width, int he
copy() : void – Text
cut() : voi
dispose()
dragDete
dragDete
equals(Ol
forceFocu
getAcces
getBackground() : Color – Control
getBackgroundImage() : Image – Control
getBorderWidth() : int – Control
getBounds() : Rectangle – Control
getCaretLineNumber() : int – Text
getCaretLocation() : Point – Text
getCaretPosition() : int – Text
getCharCount() : int – Text
getClass() : Class<?> – Object
getClientArea() : Rectangle – Scrollable
getCursor() : Cursor – Control
getData() : Object – Widget
getData(String key) : Object – Widget
getDisplay() : Display – Widget
getDoubleClickEnabled() : boolean – Text
getDragDetect() : boolean – Control
getEchoChar() : char – Text
getEditable() : boolean – Text
getEnabled() : boolean – Control
getFont() : Font – Control
getForeground() : Color – Control
getHorizontalBar() : ScrollBar – Scrollable
getLayoutData() : Object – Control
getLineCount() : int – Text
getLineDelimiter() : String – Text
getLineHeight() : int – Text
getListeners(int eventType) : Listener[] –
getLocation() : Point – Control
getMenu() : Menu – Control
getMessage() : String – Text
getMonitor() : Monitor – Control
getOrientation() : int – Text
getParent() : Composite – Control
getRegion() : Region – Control
getSelection() : Point – Text
getSelectionCount() : int – Text
getSelectionText() : String – Text
getShell() : Shell – Control
getTopIndex() : int – Text
getTopPixel() : int – Text
getVerticalBar() : ScrollBar – Scrollable
getVisible() : boolean – Control
hashCode() : int – Object
insert(String string) : void – Text
internal_dispose_GC(long context, GCDat
internal_new_GC(GCData data) : long – C
isDisposed() : boolean – Widget
isEnabled() : boolean – Control
isFocusControl() : boolean – Control
isListening(int eventType) : boolean – Wi
isReparentable() : boolean – Control
isVisible() : boolean – Control
moveAbove(Control control) : void – Con
moveBelow(Control control) : void – Cont
notify() : void – Object
notifyAll() : void – Object
notifyListeners(int eventType, Event even
pack() : void – Control
pack(boolean changed) : void – Control
paste() : void – Text
print(GC gc) : boolean – Control
redraw() : void – Control
redraw(int x, int y, int width, int height, b
removeControlListener(ControlListener lis
removeDisposeListener(DisposeListener l
removeDragDetectListener(DragDetectLis
removeFocusListener(FocusListener lister
removeHelpListener(HelpListener listener
removeKeyListener(KeyListener listener) :
removeListener(int eventType, Listener ha
removeMenuDetectListener(MenuDetectL
removeModifyListener(ModifyListener list
removeMouseListener(MouseListener liste
removeMouseMoveListener(MouseMoveLi
removeMouseTrackListener(MouseTrackL
removeMouseWheelListener(MouseWheel
setBackgroundImage(Image image) : void
setBounds(Rectangle rect) : void – Contro
setBounds(int x, int y, int width, int heigh
setCapture(boolean capture) : void – Con
setCursor(Cursor cursor) : void – Control
setData(Object data) : void – Widget
setData(String key, Object value) : void –
setDoubleClickEnabled(boolean doubleCl
setDragDetect(boolean dragDetect) : void
setEchoChar(char echo) : void – Text
setEditable(boolean editable) : void – Tex
setEnabled(boolean enabled) : void – Con
setFocus() : boolean – Control
setFont(Font font) : void – Control
setData(Object data) : void – Widget
setData(String key, Object value) : void –
setDoubleClickEnabled(boolean doubleCl
setDragDetect(boolean dragDetect) : void
setEchoChar(char echo) : void – Text
setEditable(boolean editable) : void – Tex
setEnabled(boolean enabled) : void – Con
setFocus() : boolean – Control
setFont(Font font) : void – Control
setForeground(Color color) : void – Contr
setLayoutData(Object layoutData) : void –
setLocation(Point location) : void – Contr
setLocation(int x, int y) : void – Control
setMenu(Menu menu) : void – Control
setMessage(String message) : void – Text
setOrientation(int orientation) : void – Te
setParent(Composite parent) : boolean –
setRedraw(boolean redraw) : void – Contr
setRegion(Region region) : void – Control
setSelection(int start) : void – Text
setSelection(Point selection) : void – Text
setSelection(int start, int end) : void – Te
setSize(Point size) : void – Control
setSize(int width, int height) : void – Con
toControl(Point point) : Point – Control
toControl(int x, int y) : Point – Control
toDisplay(Point point) : Point – Control
toDisplay(int x, int y) : Point – Control
toString() : String – Widget
traverse(int traversal) : boolean – Control
traverse(int traversal, Event event) : boole
traverse(int traversal, KeyEvent event) : b
update() : void – Control
wait() : void – Object
wait(long timeout) : void – Object
wait(long timeout, int nanos) : void – Obj
DELIMITER : String – Text
LIMIT : int – Text
All 164 Methods of Text ?


JButton? 381 Methods.

Code Completion…

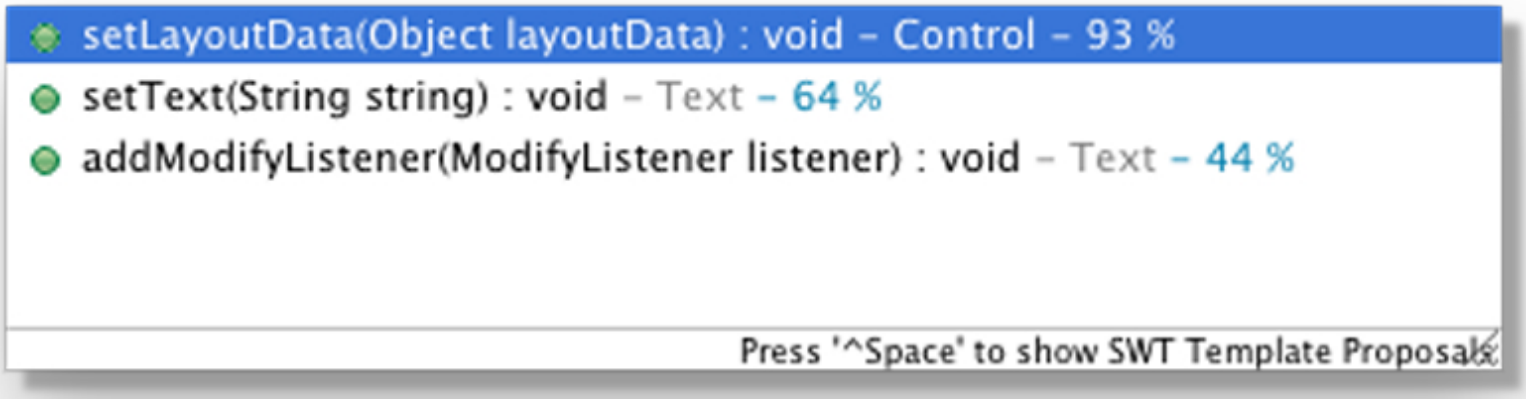
```
@Override
protected Control createDialogArea(final Composite parent) {
    final Composite container = (Composite) super.createDialogArea(parent);

    swtTextWidget = new Text(container, SWT.BORDER);
    swtTextWidget.|
    return container;
}
```



What does the developer need, i.e., which methods should the code completion present to the user?

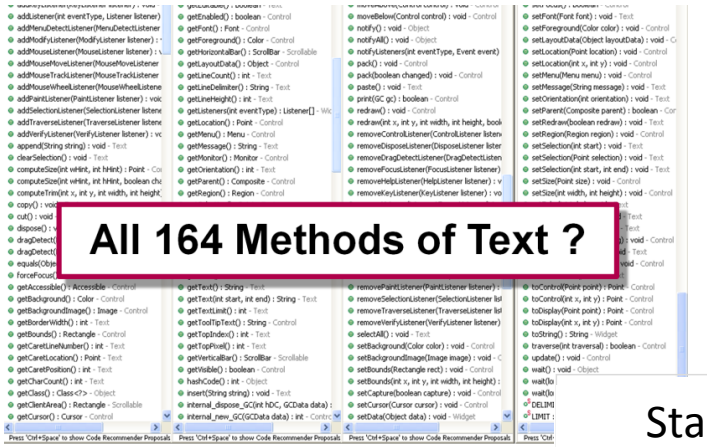
Intelligent Code Completion



… or just the three missing ones?

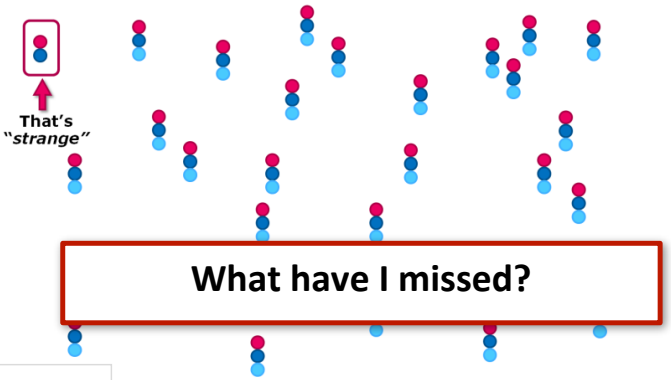
Tools Outline

Intelligent Code Completion



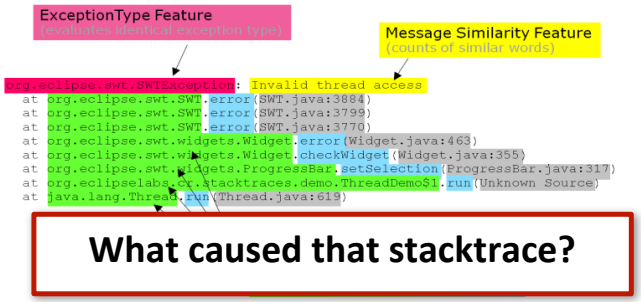
All 164 Methods of Text ?

Smart Bug Detection



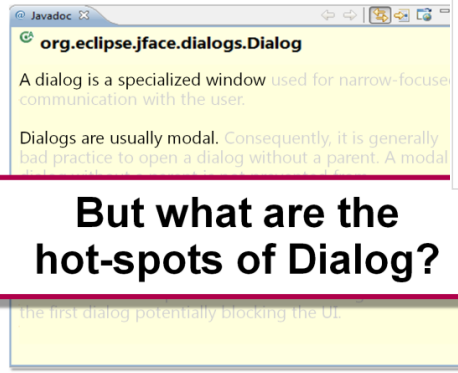
What have I missed?

Stacktrace Search Engine



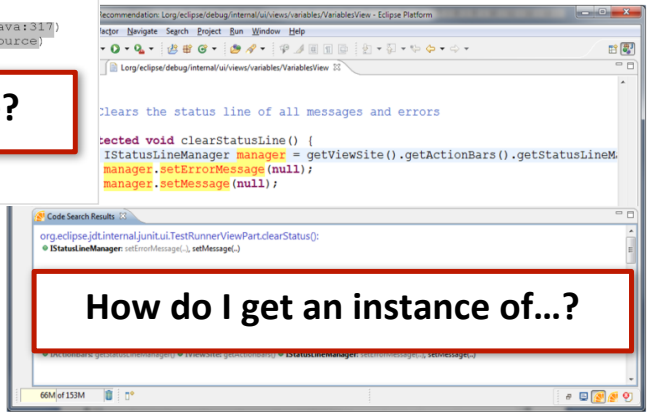
What caused that stacktrace?

Extended Documentati



But what are the hot-spots of Dialog?

ode Example Recommender



How do I get an instance of…?

“Developers who ~~bought~~ overwrote this method typically also overwrote...”

USAGE-DRIVEN JAVADOC

In ~~good~~ documentation we trust...

```
/**
 * Rollsback the transaction if any and clears different lists to
 * start with an empty resource again.
 * Note that the super.doUnload is not called because that clears
 * the list resulting in all kinds of undesirable inverseremoves.
 */
@Override
protected void doUnload() {
   ...
}
```

No? Are you sure?

Generating high-quality API documentation

```
/**
 * The number of questions.
 */
private int numberOfQuestions;


/**
 * Sets the number of questions.
 *
 * @param numberOfQuestions the number of questions
 * @throws IllegalArgumentException the illegal argument exception
 */
public void setNumberOfQuestions(int numberOfQuestions)
                                 throws IllegalArgumentException {
    if (numberOfQuestions < 0) {
        throw new IllegalArgumentException("numberOfQuestions < 0");
    }
    this.numberOfQuestions = numberOfQuestions;
}
```

Generating ~~high-quality~~ API documentation

```
/**
 * The number of questions.
 */
private int numberOfQuestions;


/**
 * Sets the number of questions.
 *
 * @param numberOfQuestions the number of questions
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                                 throws IllegalArgumentException {
    if (numberOfQuestions < 0) {
        throw new IllegalArgumentException("numberOfQuestions < 0");
    }
    this.numberOfQuestions = numberOfQuestions;
}
```

What people say about JAutodoc...

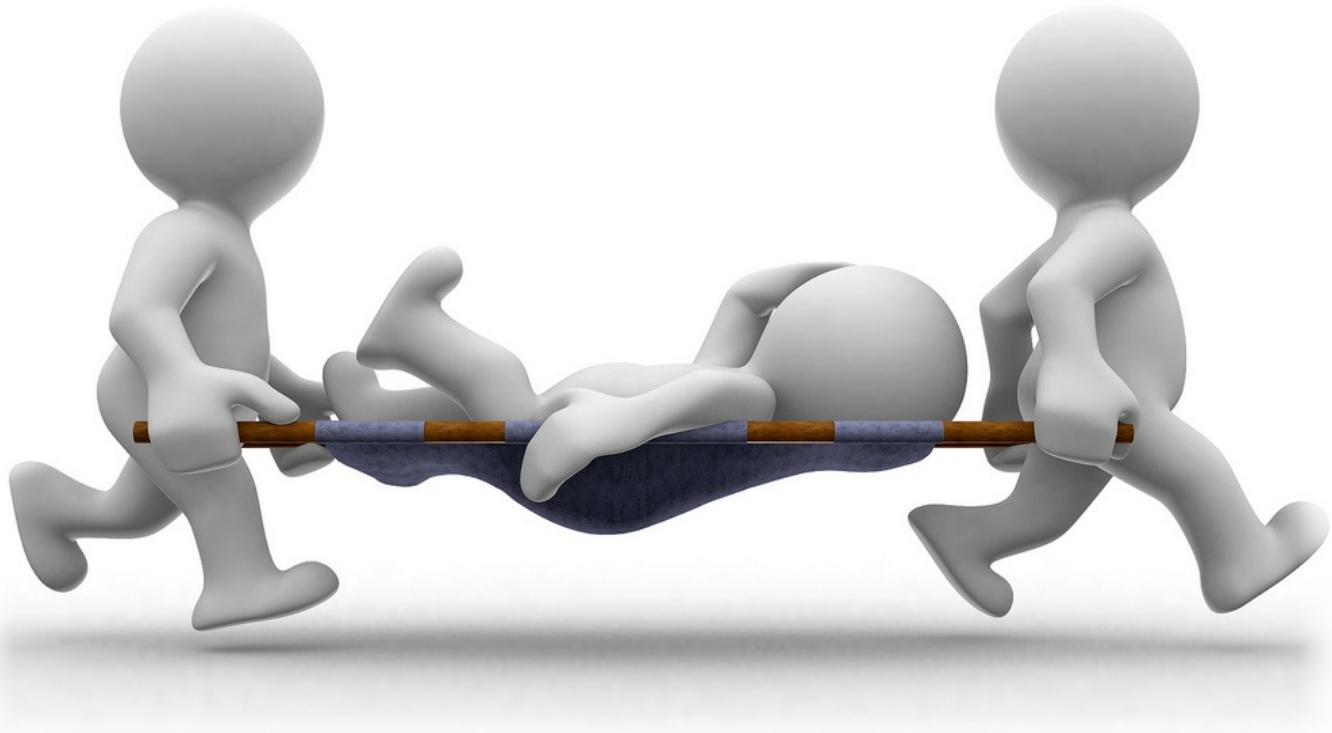
User: Anonymous	Rating: 9	2009-08-02 11:32:37
Wow exactly what I needed!		

User: Anonymous	Rating: 9	2009-02-13 19:58:32
Thank you... this plugin rocks!		

User: Anonymous	Rating: 9	2009-02-13 19:58:32
Works perfectly. Smarter than I expected!		

WTH? What did you expect?!

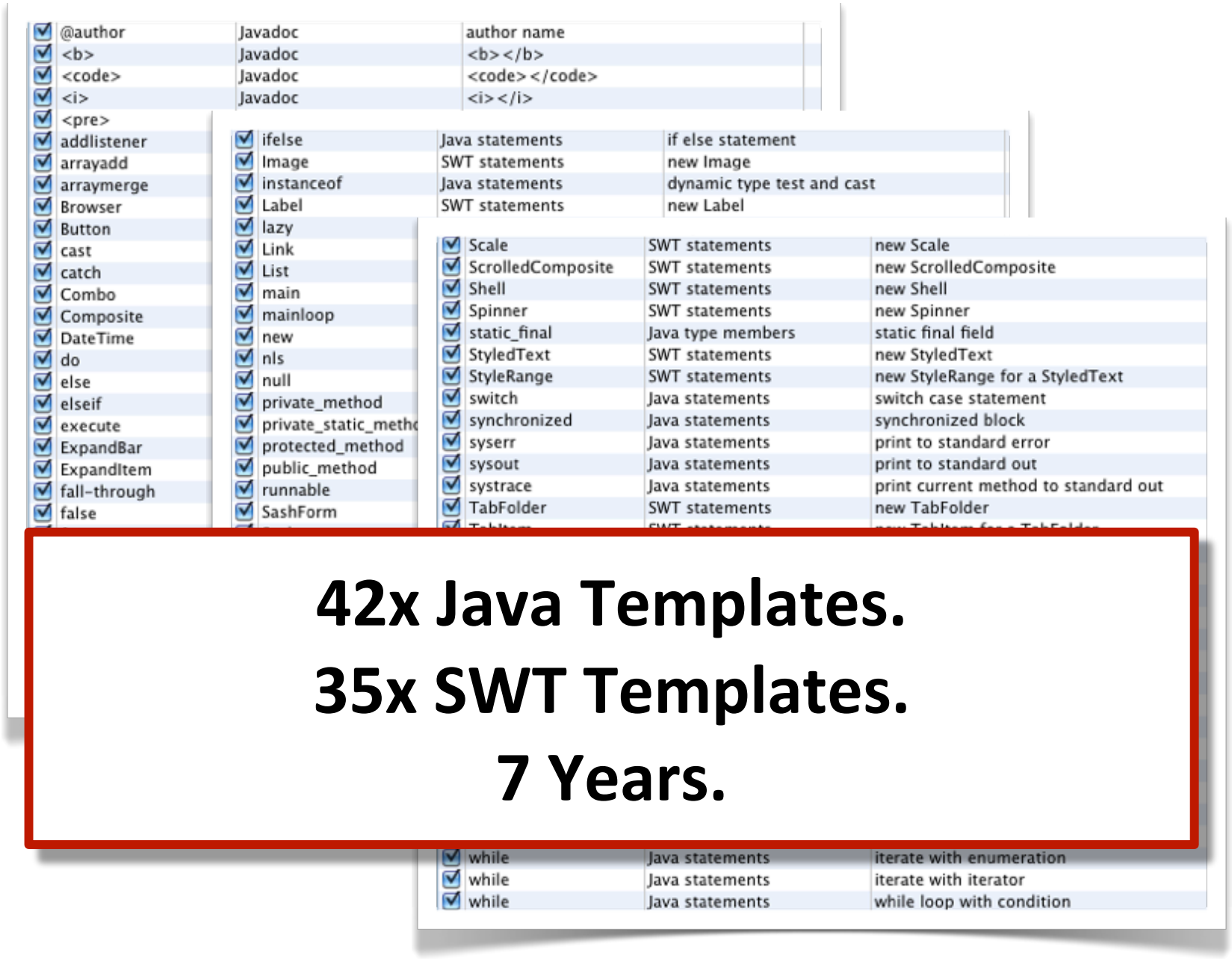
How Recommenders is coming to rescue...



“Templates meet Social - reloaded!”

SNIPMATCH

Eclipse Java Editor Templates



42x Java Templates.

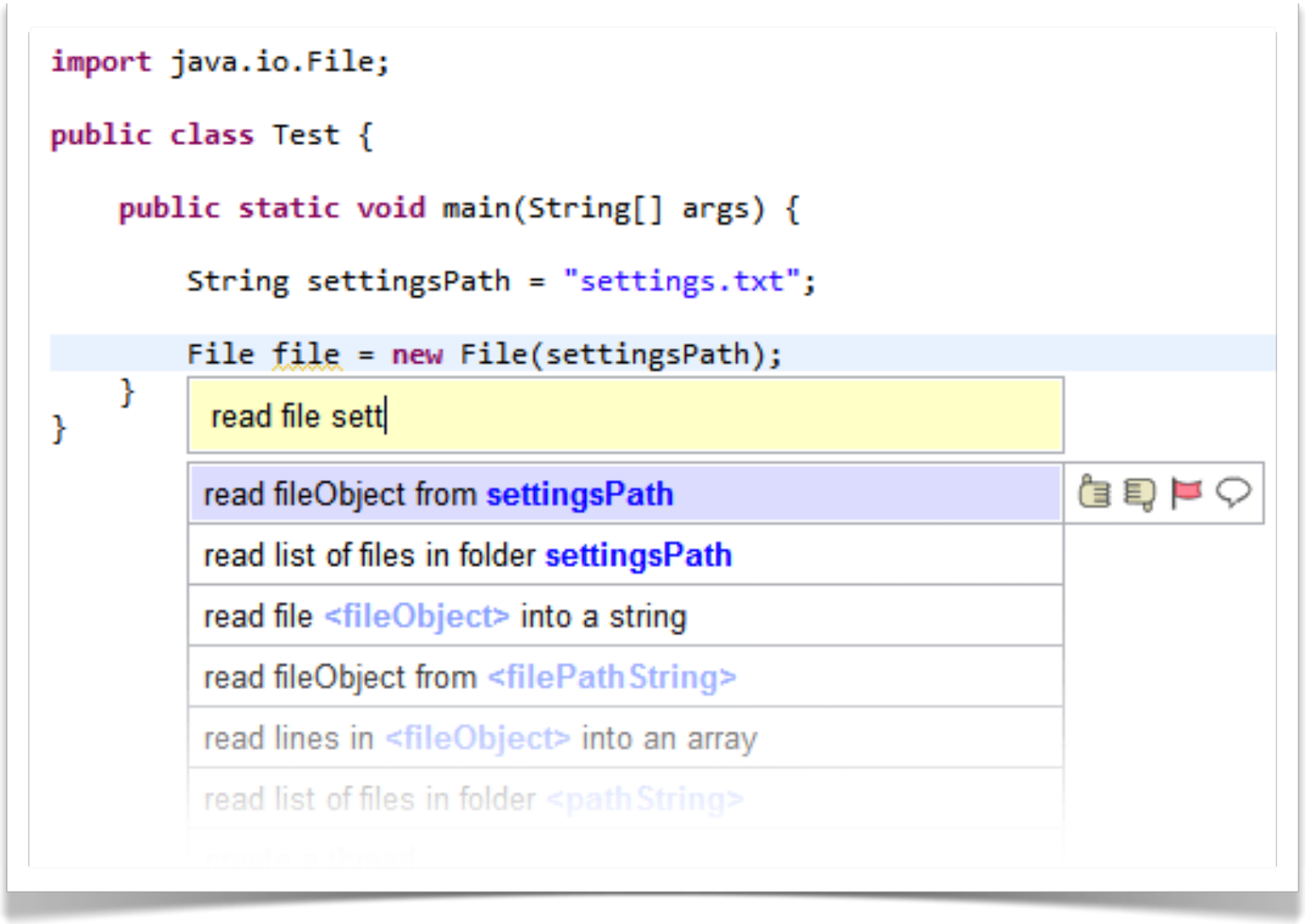
35x SWT Templates.

7 Years.

The rise of code snippet repositories

and many more...

Searching snippets in your IDE...



“Why is Google Codesearch not ‘google for code search’? ”

CODE-SEARCH ENGINES LIFT OFF

How many request per minutes do code search engines have?

20

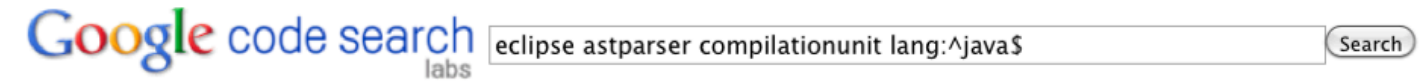
Number for koders.com in 2009 according to "Analyzing and mining a code search engine usage log"
http://dx.doi.org/10.1007/s10664-010-9144-6

Navigating the API jungle…

```
private CompilationUnit createCompilationUnit(String source) {

    // how can I create and configure an ASTParser?
    ASTParser parser = null;
    parser.setSource(source.toCharArray());

    // ASTParser --> CompilationUnit: how?
    CompilationUnit cu = null;
    return cu;
}
```

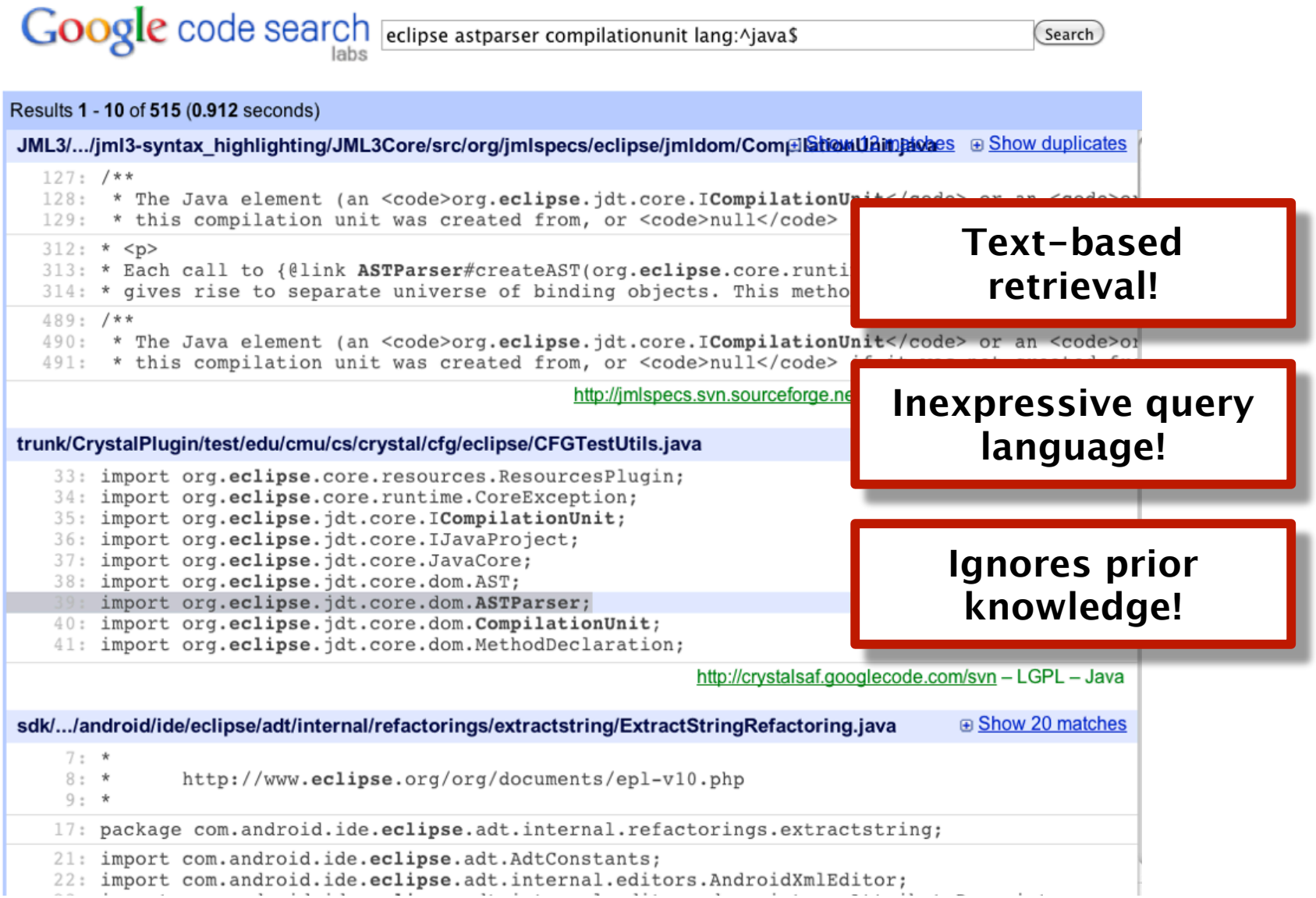
How to solve
String -> ASTParser -> CompilationUnit?

When asking Google code search...



Results **1** - **10** of **515** (**0.912** seconds)

Why?



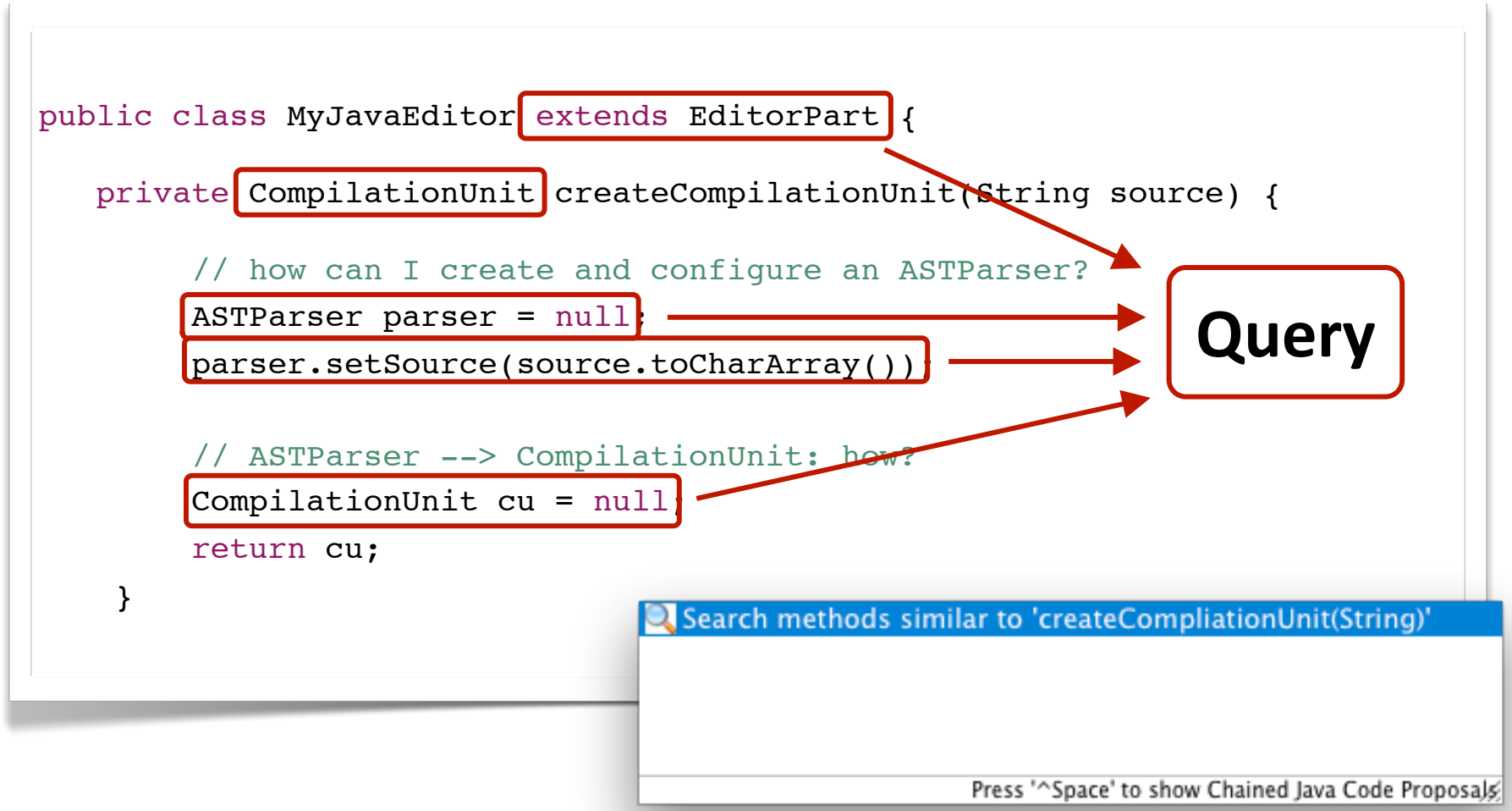
Text-based retrieval!

Inexpressive query language!

Ignores prior knowledge!

Example code search engine

```
public class MyJavaEditor extends EditorPart {

    private CompilationUnit createCompilationUnit(String source) {

        // how can I create and configure an ASTParser?
        ASTParser parser = null;
        parser.setSource(source.toCharArray());

        // ASTParser --> CompilationUnit: how?
        CompilationUnit cu = null;
        return cu;
    }
```



Sample search query

Extracted from MyJavaEditor.createCompilationUnit():

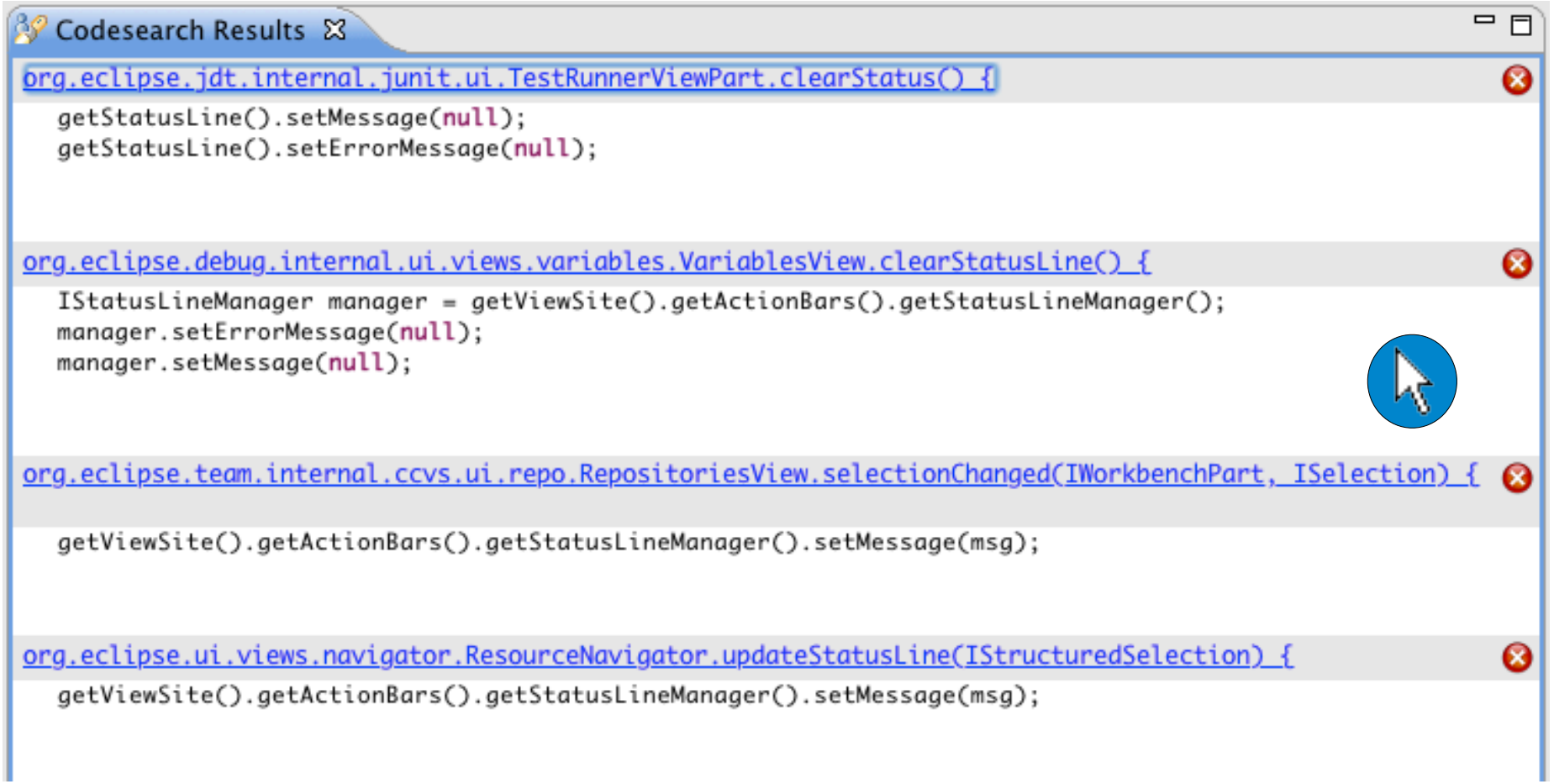
```
--- data ---
extends: org.eclipse.ui.EditorPart
uses:    org.eclipse.jdt.core.CompilationUnit
uses:    org.eclipse.jdt.core.ASTParser
calls:   org.eclipse.jdt.core.ASTParser.setSource(char[])

--- requested ---
def:     org.eclipse.jdt.core.CompilationUnit (def=null)
def:     org.eclipse.jdt.core.ASTParser       (def=null)
```

In development...

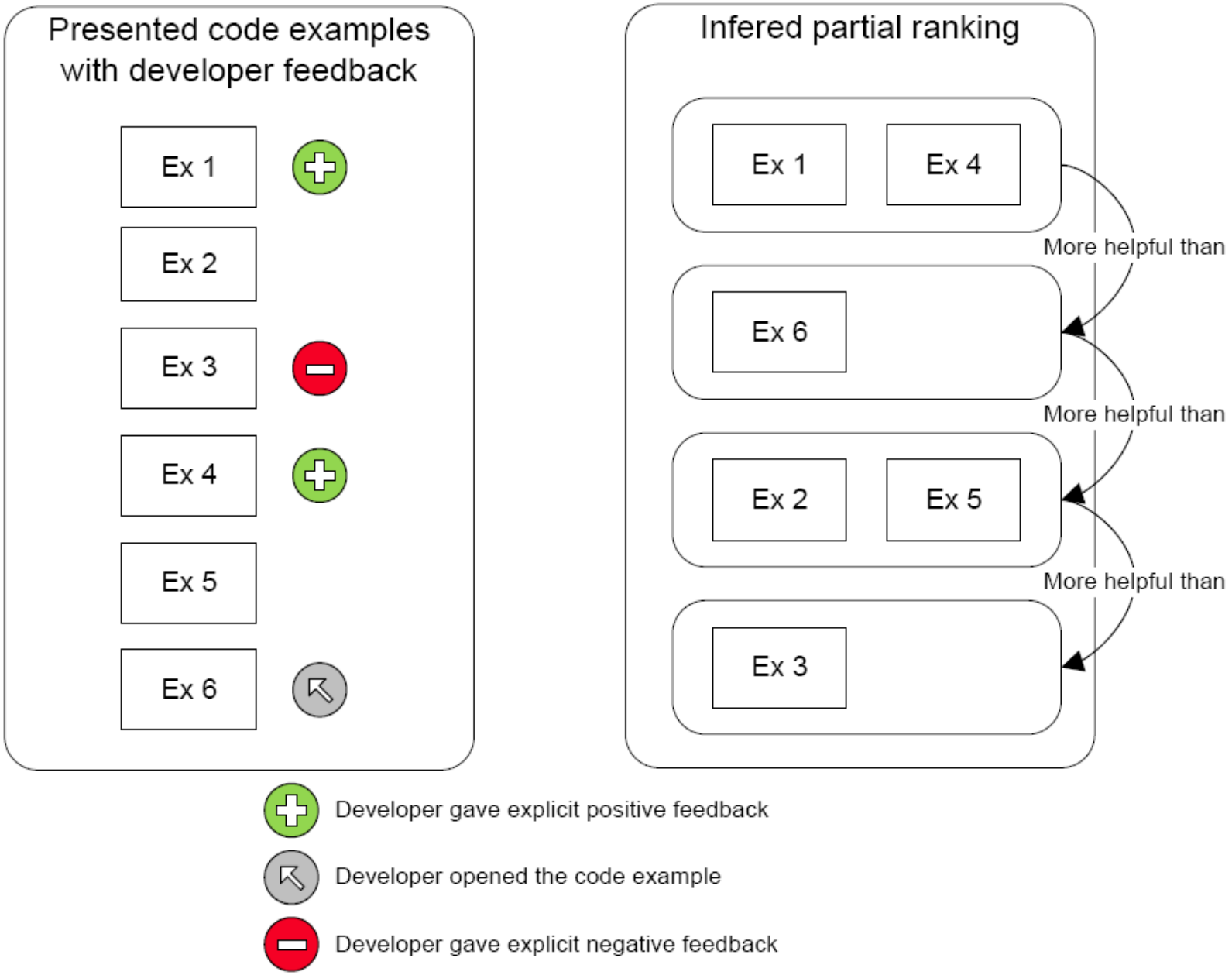
“Why is Google Codesearch not ‘google for code search’? ”

LEVERAGING USER FEEDBACK TO IMPROVE CODE SEARCH ENGINES

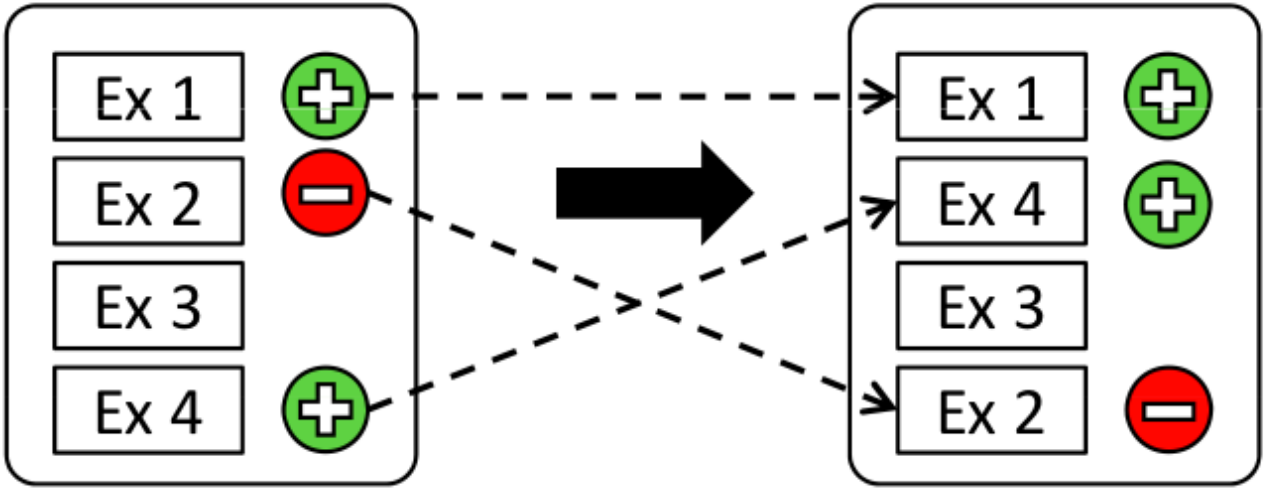
Leveraging user feedback



Refine the ranking based on feedback



Learning how to rank



Ranking the examples

$$score(d, q) = \sum_{i=0}^{n} w_i \cdot f_i(d, q)$$

document

query

weight

(-∞..+∞)

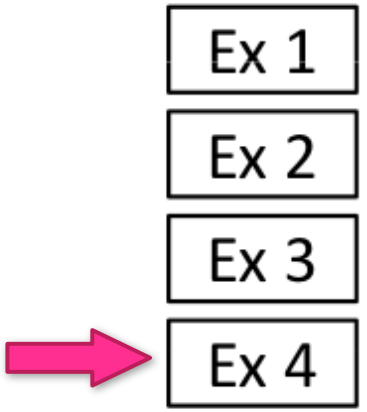
feature-score `i`

[0..1]

Updating the feature weights...

feature	weight	Ex 1	Ex 2	Ex 3	Ex 4
f_1	1.0	1.0	0.2	0.5	0.8
f_2	0.5	0.4	0.0	0.8	0.0
f_3	1.0	0.2	1.0	0.1	0.1
score	—	1.4	1.2	1.0	0.9

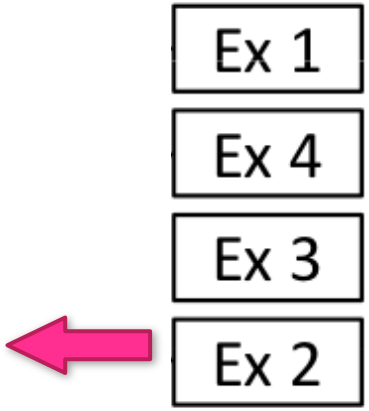
(a) before optimization



10.000 *

feature	weight	Ex 1	Ex 2	Ex 3	Ex 4
f_1	2.0	1.0	0.2	0.5	0.8
f_2	0.5	0.4	0.0	0.8	0.0
f_3	-1.0	0.2	1.0	0.1	0.1
score	—	2.0	-0.6	1.3	1.5

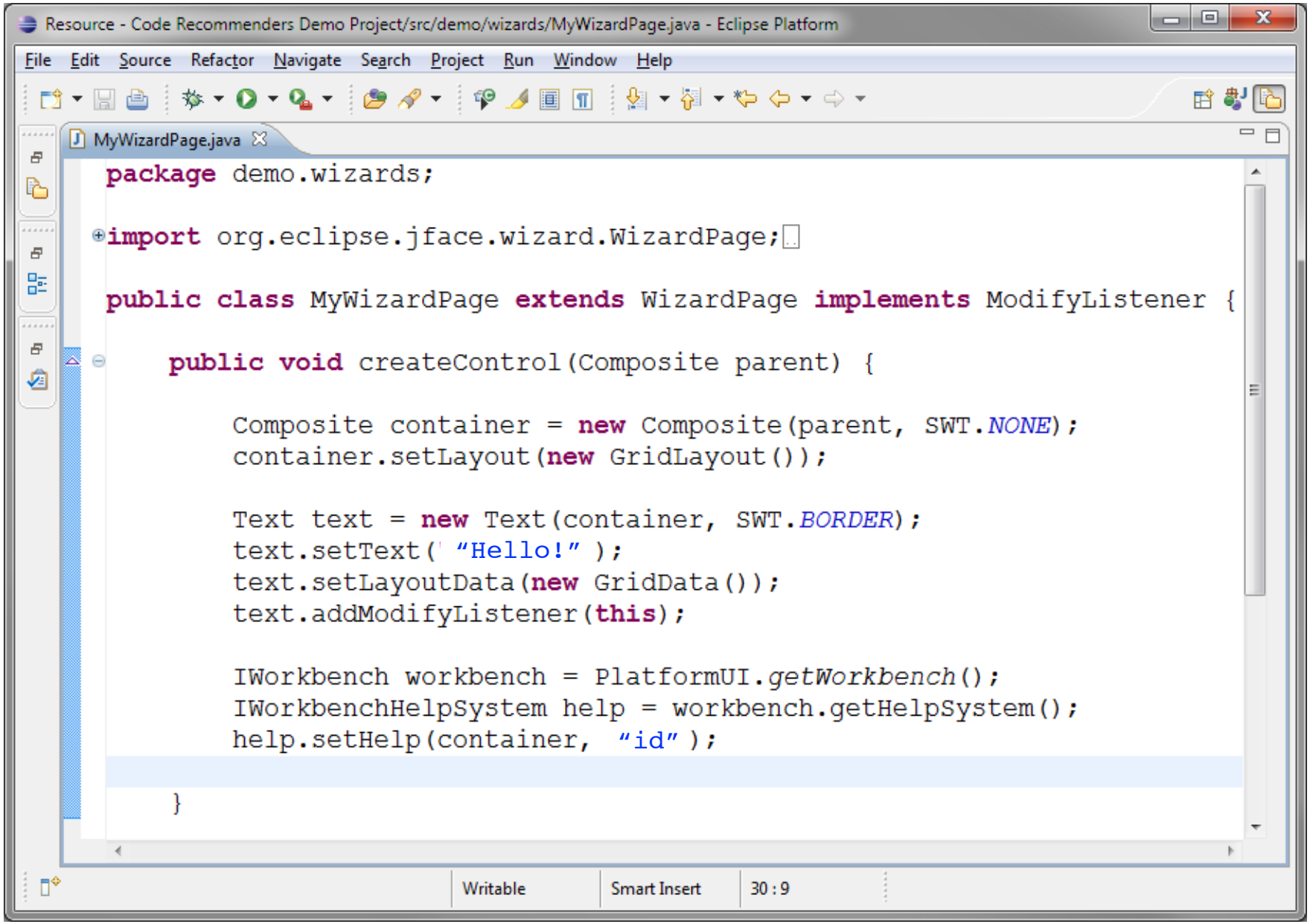
(b) after optimization



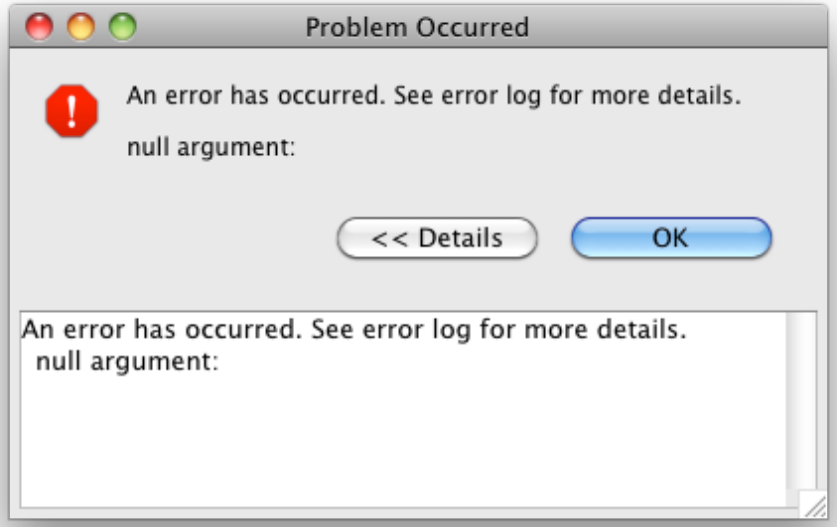
“The good ones in the crock, the bad ones in… the problem view.”

SMART BUG DETECTION – DRIVEN BY REAL USAGES

What's wrong with this code?



At runtime you get…



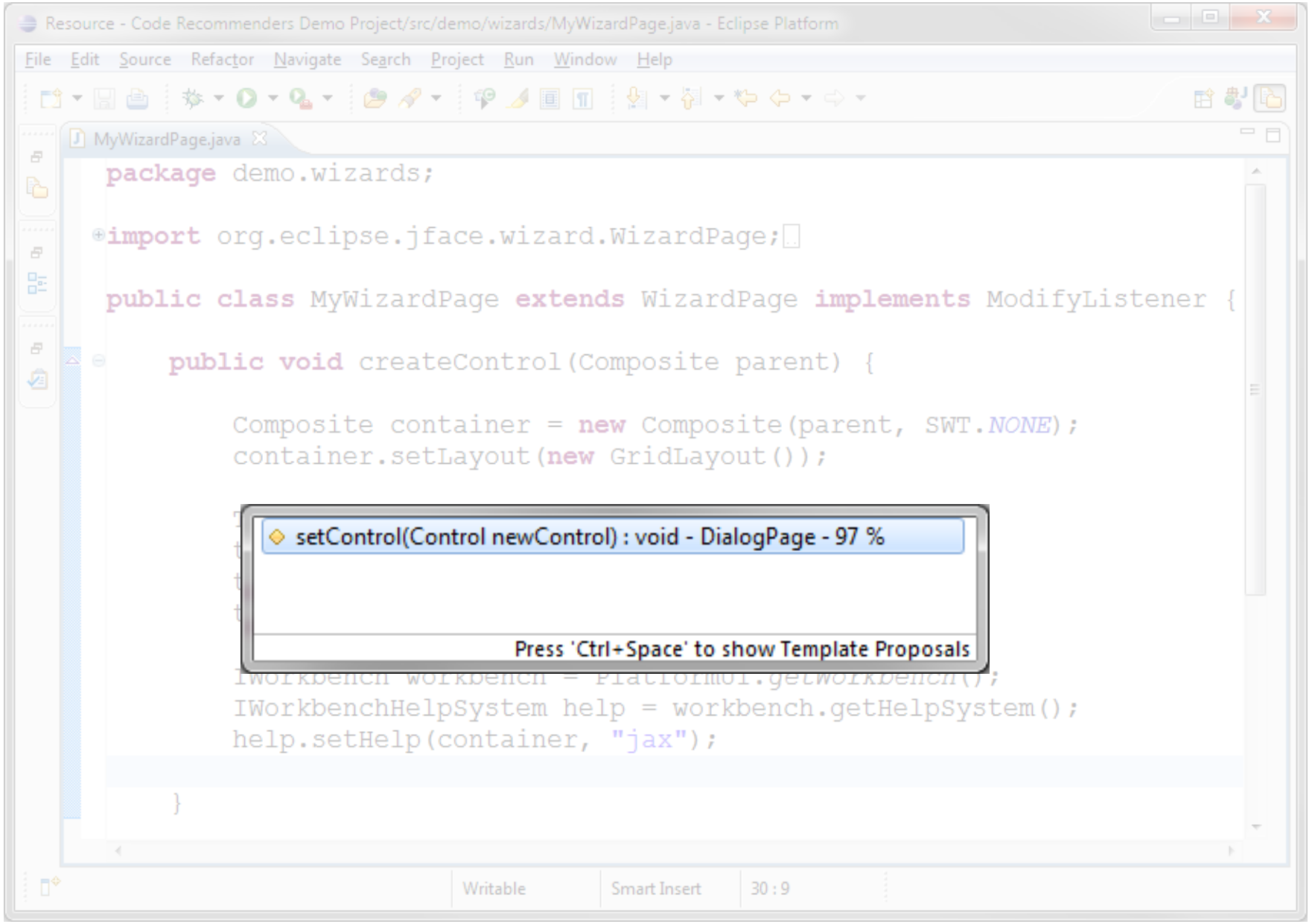
...and a lengthy stacktrace

```
org.eclipse.core.runtime.AssertionFailedException: null argument:
  at org.eclipse.core.runtime.Assert.isNotNull(Assert.java:85)
  at org.eclipse.core.runtime.Assert.isNotNull(Assert.java:73)
  at org.eclipse.jface.wizard.Wizard.createPageControls(Wizard.java:174)
  at org.eclipse.jface.wizard.WizardDialog.createPageControls(WizardDialog.java:734)
  at org.eclipse.jface.wizard.WizardDialog.setWizard(WizardDialog.java:1162)
  at org.eclipse.jface.wizard.WizardDialog.updateForPage(WizardDialog.java:1221)
  at org.eclipse.jface.wizard.WizardDialog.access$4(WizardDialog.java:1218)
  at org.eclipse.jface.wizard.WizardDialog$6.run(WizardDialog.java:1207)
  at org.eclipse.swt.custom.BusyIndicator.showWhile(BusyIndicator.java:70)
  at org.eclipse.jface.wizard.WizardDialog.showPage(WizardDialog.java:1205)
  at org.eclipse.ui.internal.dialogs.ImportExportPage.treeDoubleClicked(ImportExportPage.java)
  at org.eclipse.ui.internal.dialogs.ImportPage$2.doubleClick(ImportPage.java:72)
  at org.eclipse.jface.viewers.StructuredViewer$1.run(StructuredViewer.java:824)
  at org.eclipse.core.runtime.SafeRunner.run(SafeRunner.java:42)
  at org.eclipse.ui.internal.JFaceUtil$1.run(JFaceUtil.java:49)
  at org.eclipse.jface.util.SafeRunnable.run(SafeRunnable.java:175)
  at org.eclipse.jface.viewers.StructuredViewer.fireDoubleClick(StructuredViewer.java:822)
  at org.eclipse.jface.viewers.AbstractTreeViewer.handleDoubleSelect(AbstractTreeViewer.java)
  at org.eclipse.jface.viewers.StructuredViewer$4.widgetDefaultSelected(StructuredViewer.java)
```

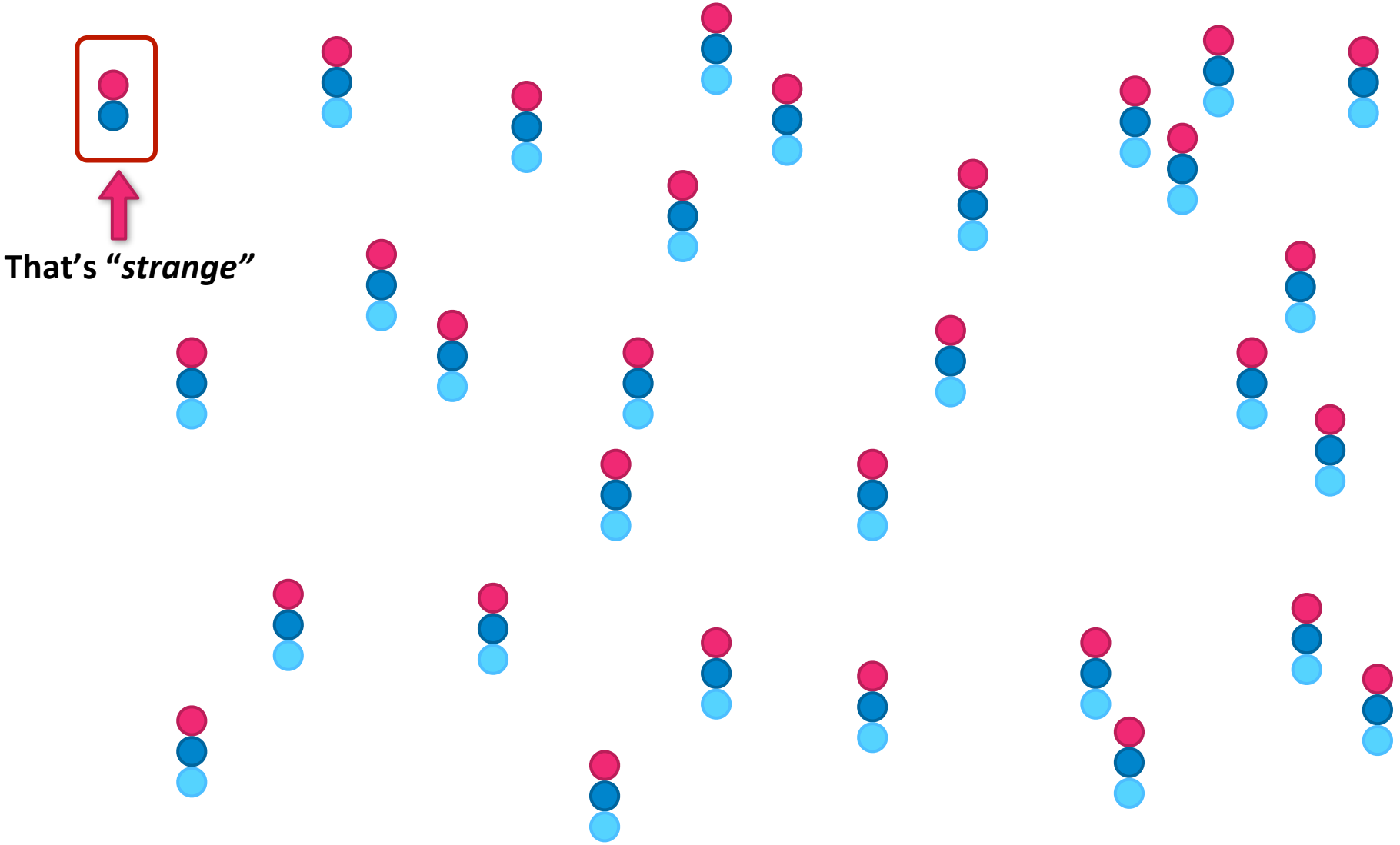
...

So what have we missed?

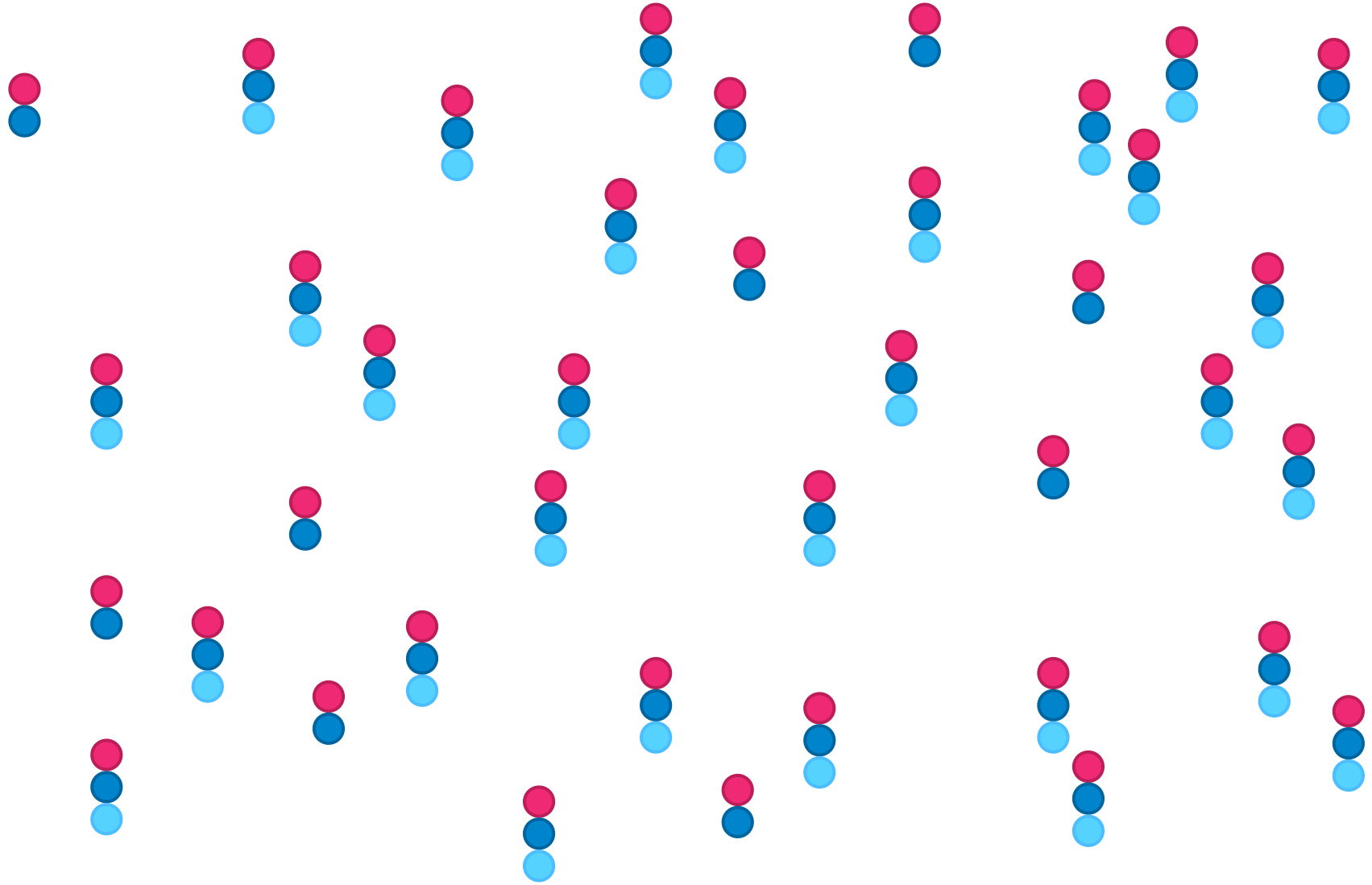
If all of your colleagues do it – why don't you?



How to detect such wrong uses?

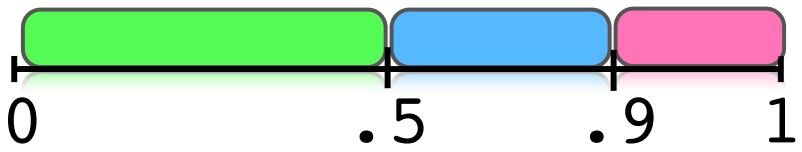


How to detect such wrong uses?



Just one formula…

$$strangeness(x) = 1 - \frac{|E(x)|}{|E(x)| + |A(x)|}$$

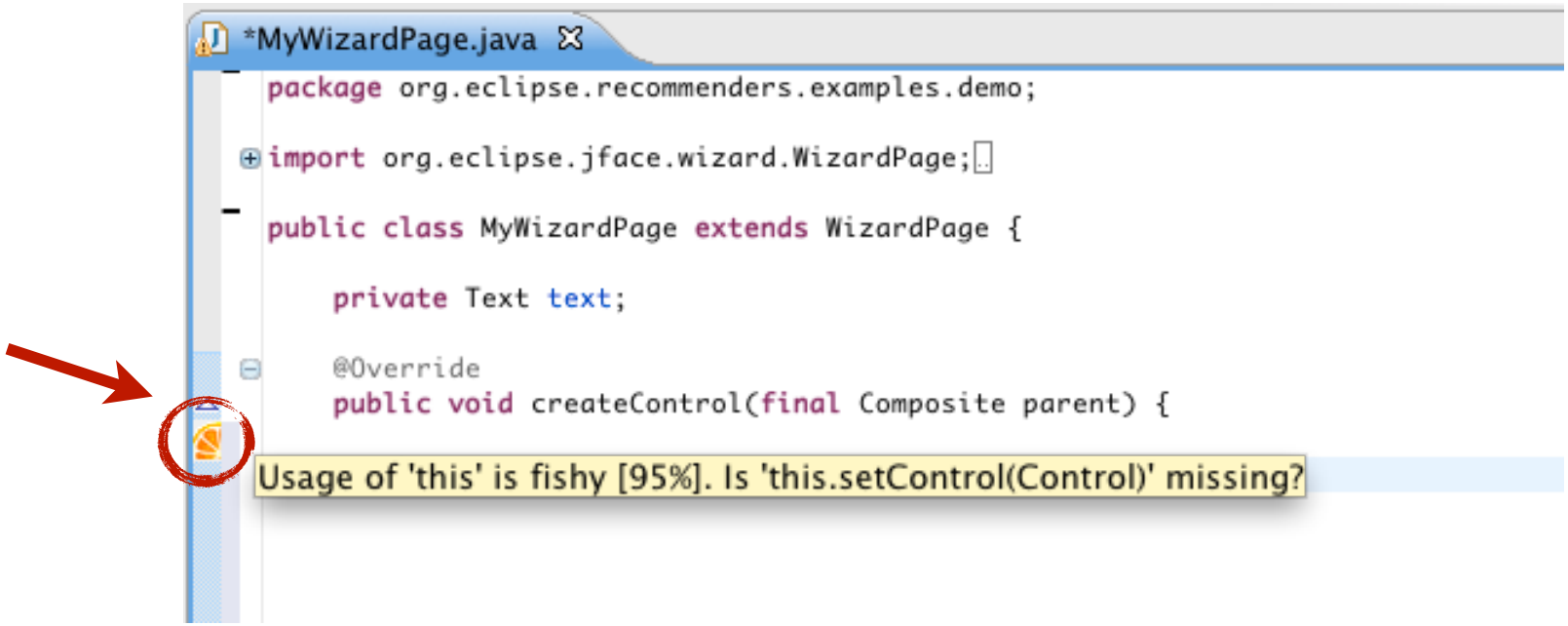


x = {observed method calls on a variable}

E(x) = {*exact* similar usages for variables of type x in the code base}

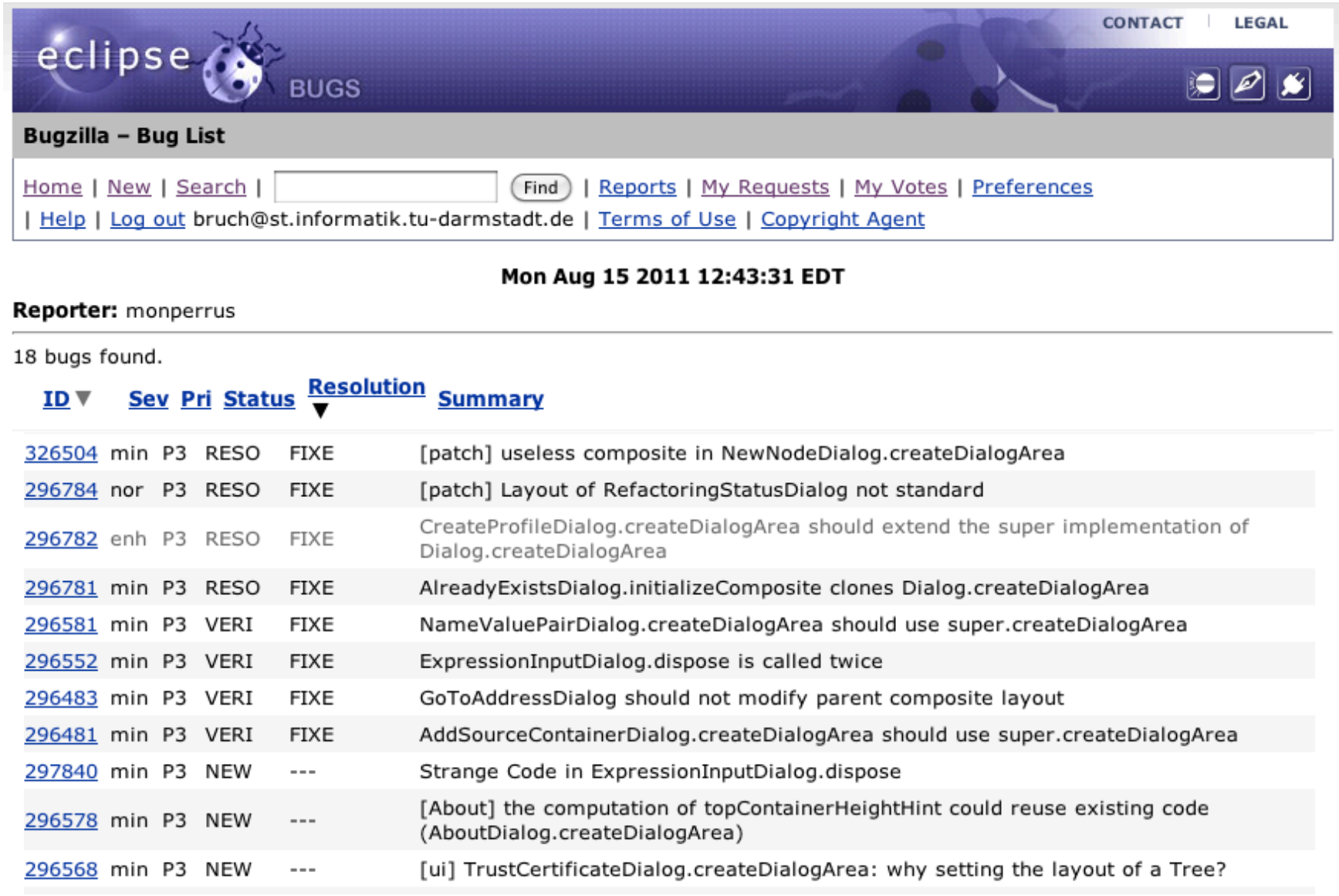
A(x) = {*almost* similar usages, i.e., *x+1 method call}*

Missing Calls Detector in Eclipse



In development...

Applied on Eclipse 3.5...



eclipse BUGS

CONTACT | LEGAL

Bugzilla – Bug List

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Mon Aug 15 2011 12:43:31 EDT

Reporter: monperrus

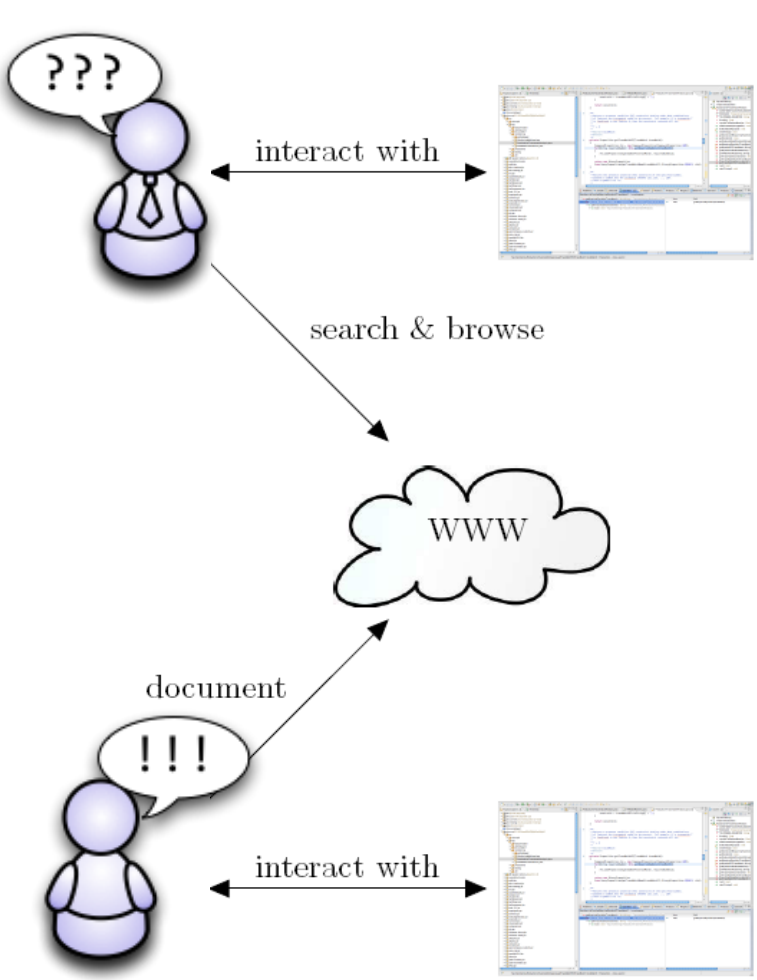
18 bugs found.

ID	Sev	Pri	Status	Resolution	Summary
326504	min	P3	RESO	FIXE	[patch] useless composite in NewNodeDialog.createDialogArea
296784	nor	P3	RESO	FIXE	[patch] Layout of RefactoringStatusDialog not standard
296782	enh	P3	RESO	FIXE	CreateProfileDialog.createDialogArea should extend the super implementation of Dialog.createDialogArea
296781	min	P3	RESO	FIXE	AlreadyExistsDialog.initializeComposite clones Dialog.createDialogArea
296581	min	P3	VERI	FIXE	NameValuePairDialog.createDialogArea should use super.createDialogArea
296552	min	P3	VERI	FIXE	ExpressionInputDialog.dispose is called twice
296483	min	P3	VERI	FIXE	GoToAddressDialog should not modify parent composite layout
296481	min	P3	VERI	FIXE	AddSourceContainerDialog.createDialogArea should use super.createDialogArea
297840	min	P3	NEW	---	Strange Code in ExpressionInputDialog.dispose
296578	min	P3	NEW	---	[About] the computation of topContainerHeightHint could reuse existing code (AboutDialog.createDialogArea)
296568	min	P3	NEW	---	[ui] TrustCertificateDialog.createDialogArea: why setting the layout of a Tree?

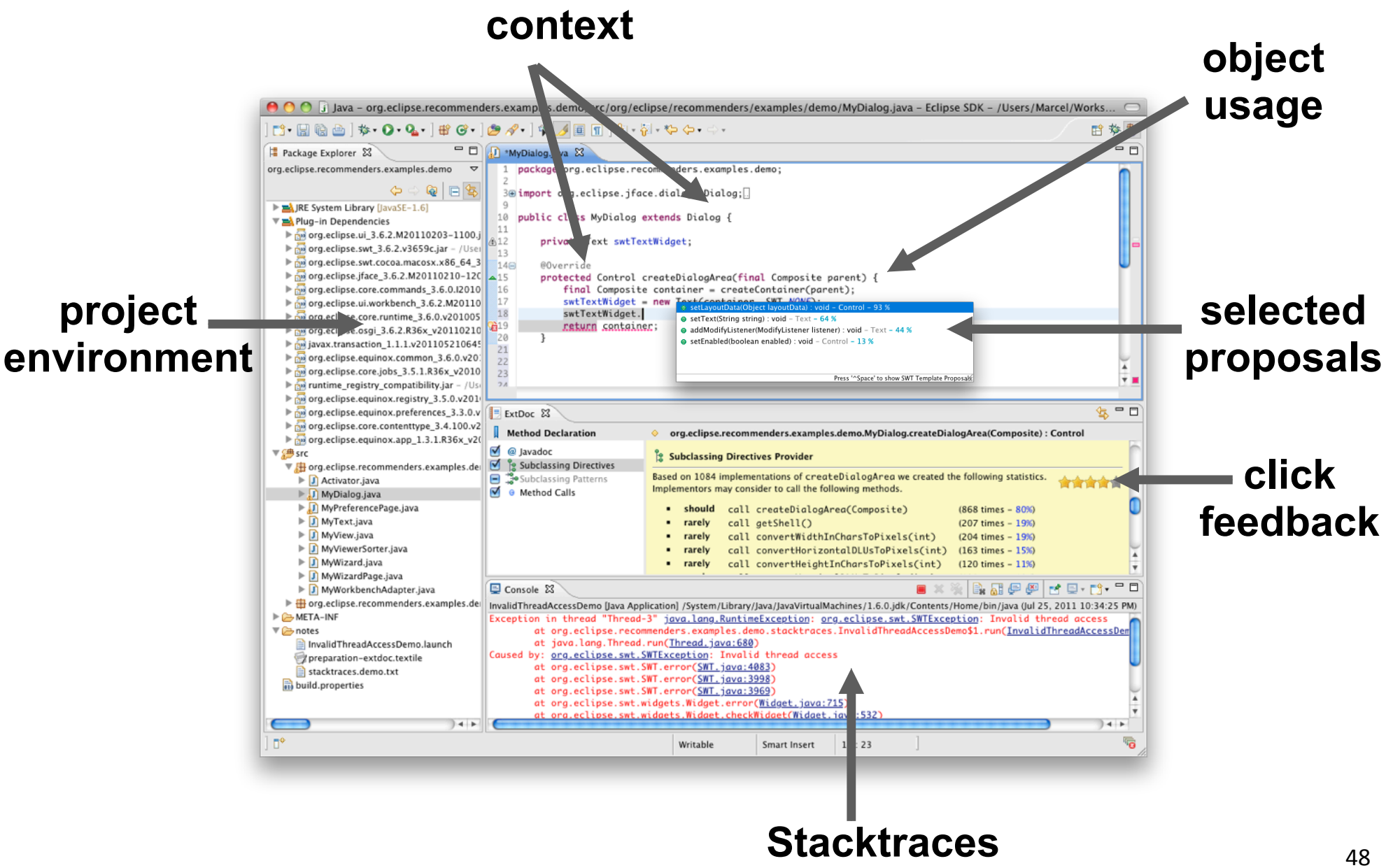
“IDE 2.0? Leveraging the wisdom of the (Eclipse) community…”

ECLIPSE CODE RECOMMENDERS

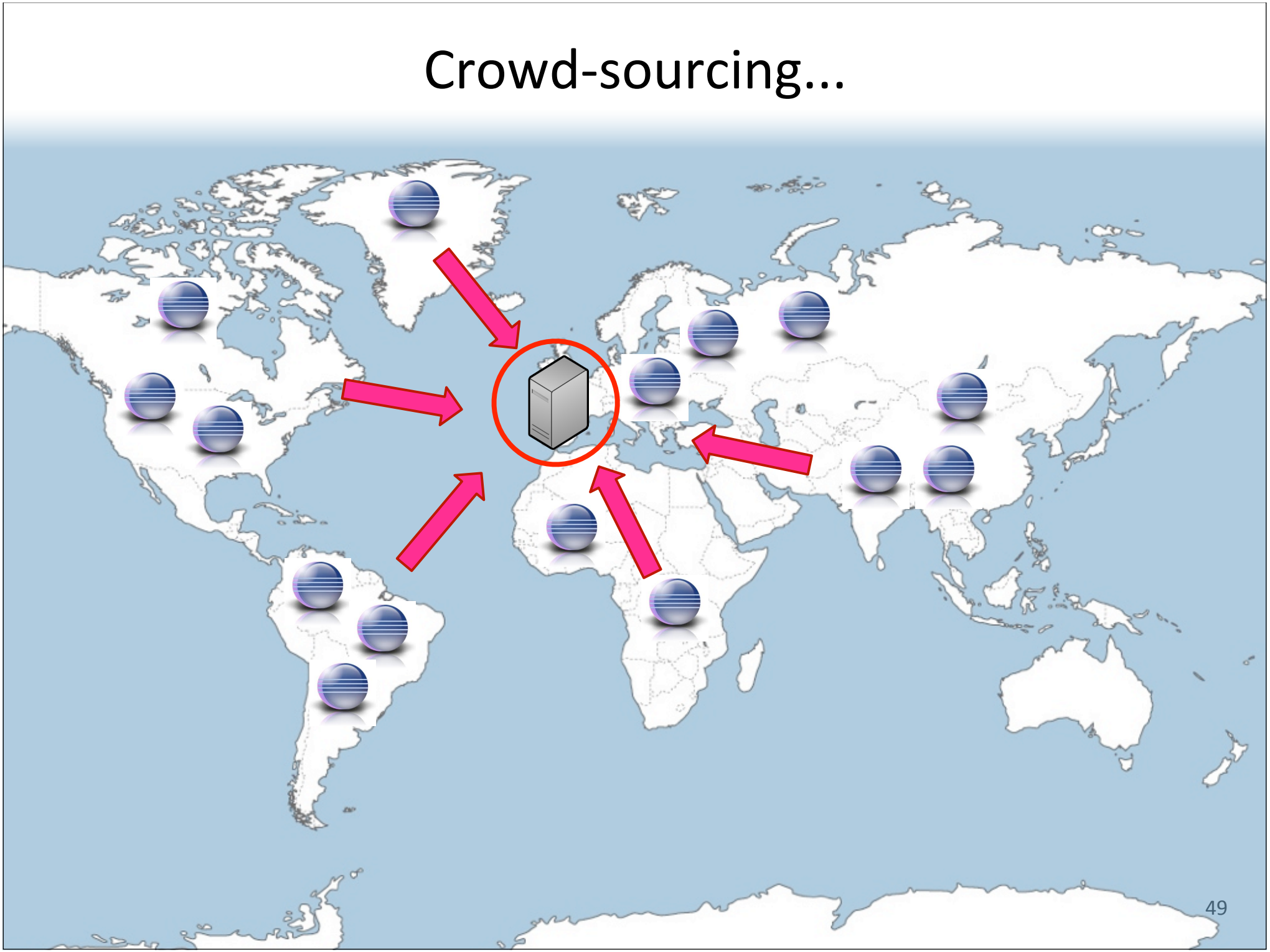
From IDE 1.0 to IDE 2.0



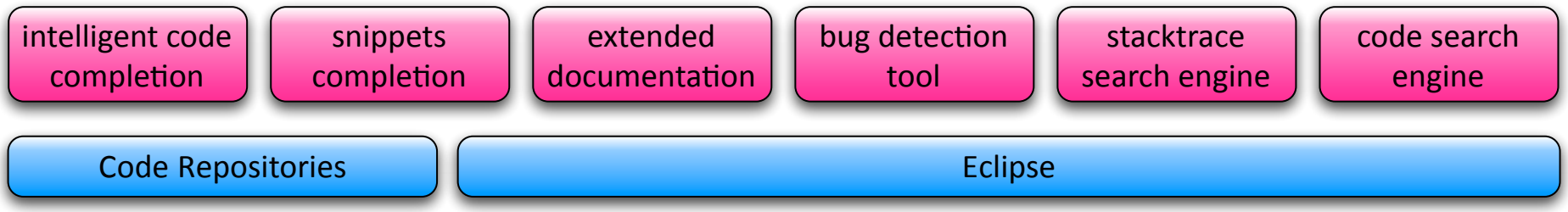
Leveraging your IDE's build environment



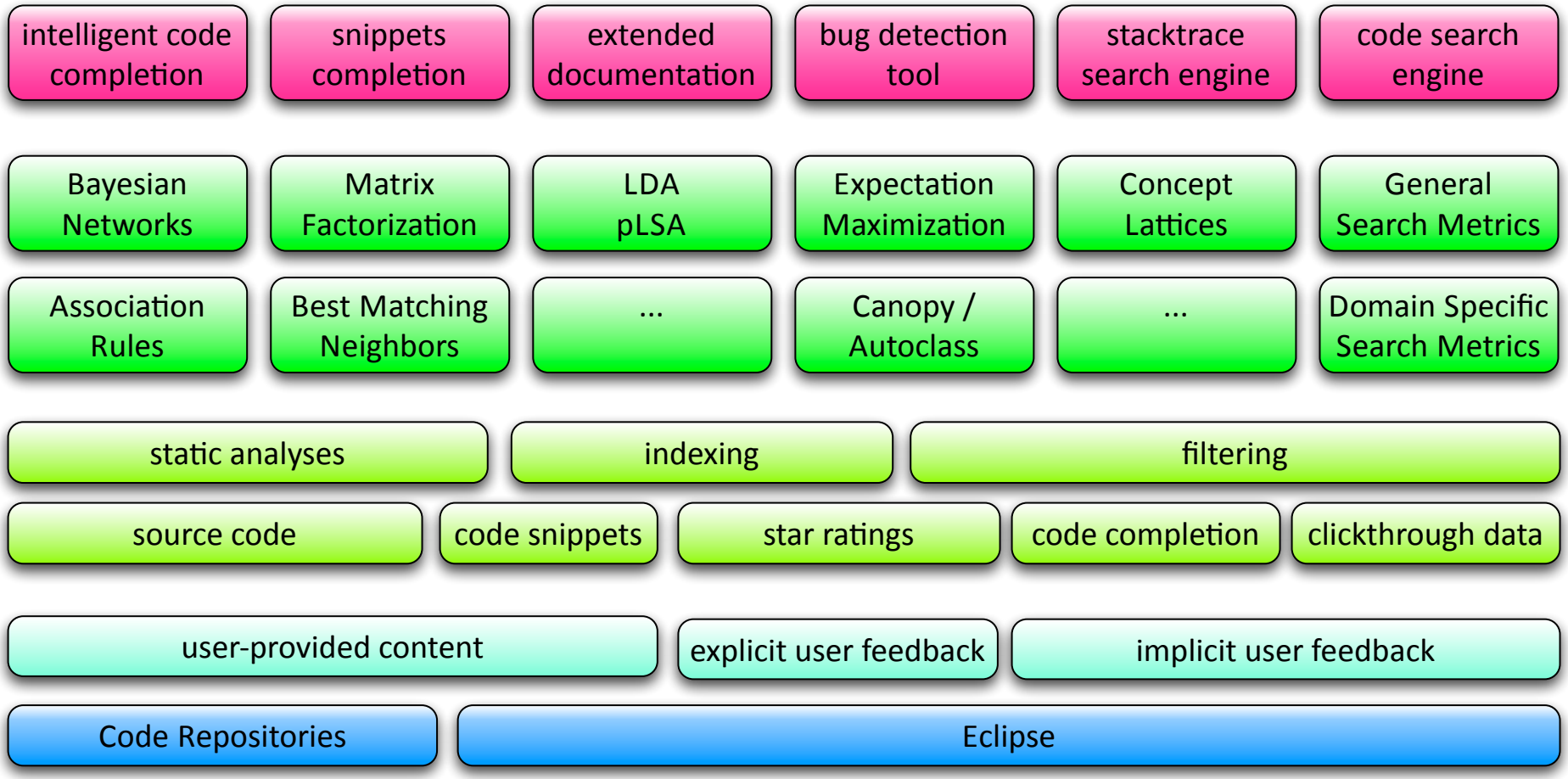
Crowd-sourcing...



Eclipse Code Recommenders Technology Stack



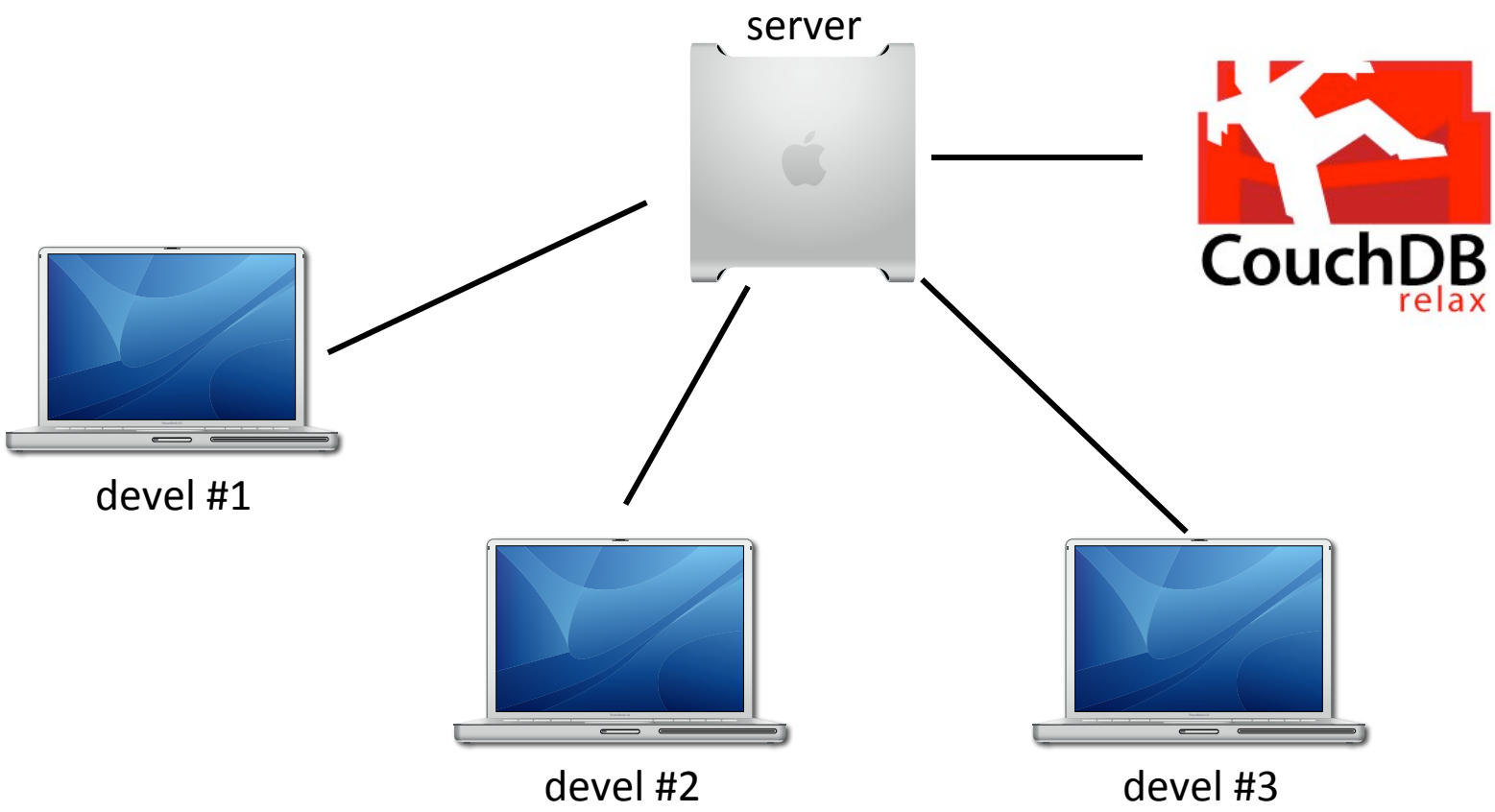
Eclipse Code Recommenders Technology Stack



“Support your own framework. Live walk-through...”

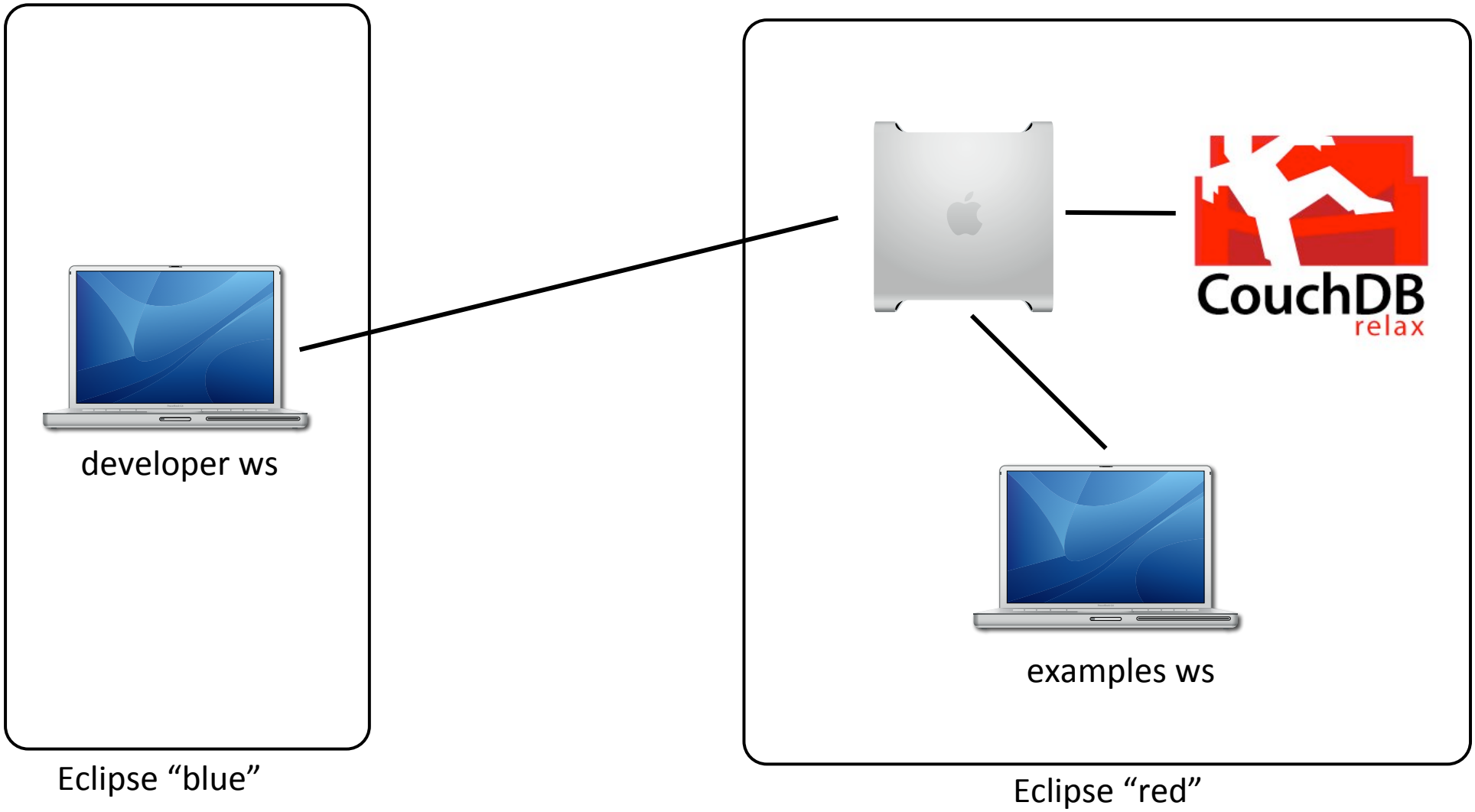
TEAM SERVER FOR ANDROID

Code Recommenders team server



In development...

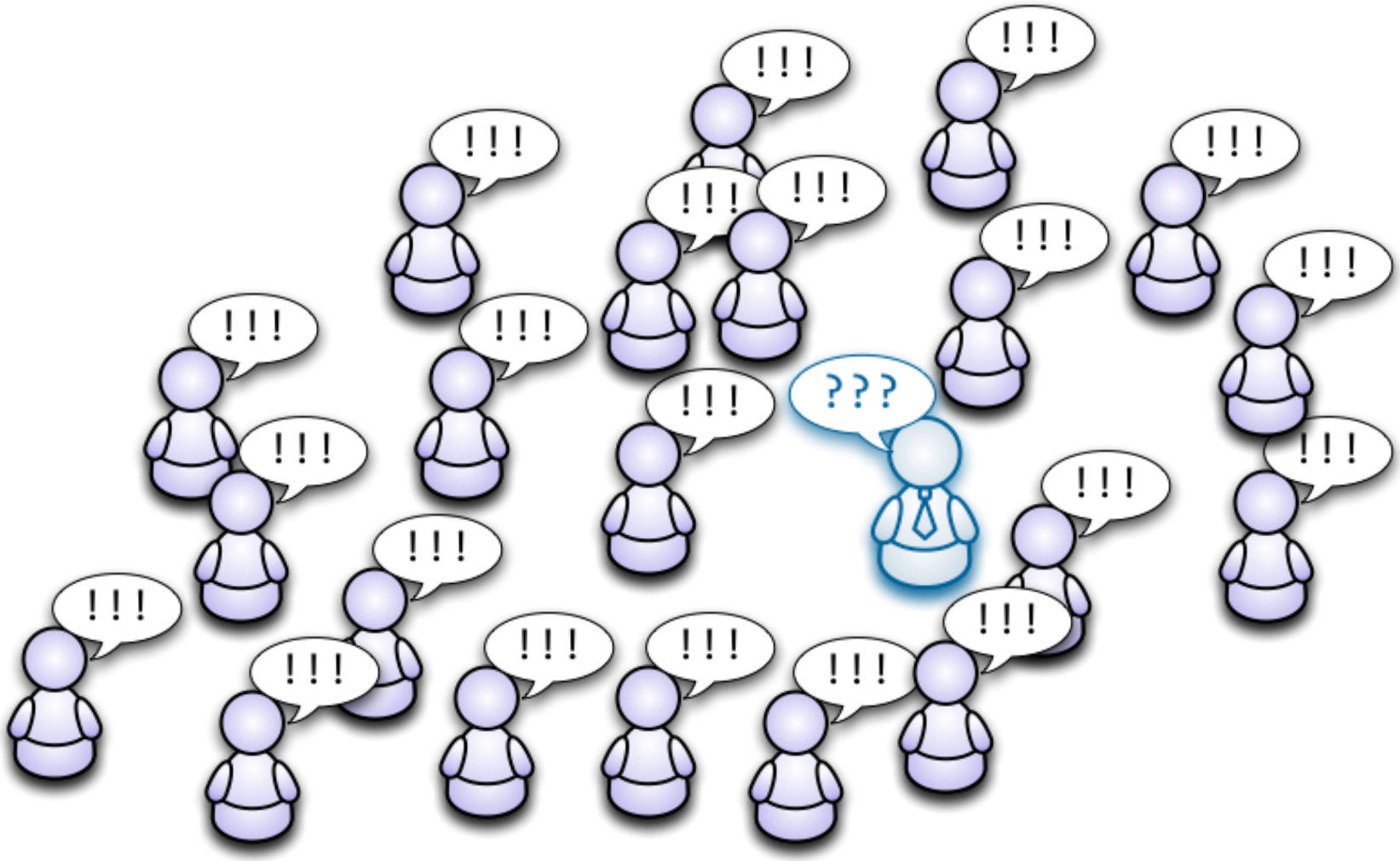
Demo setup


developer ws
CouchDB
relax
examples ws
Eclipse “blue”
Eclipse “red”

Contributors so far…

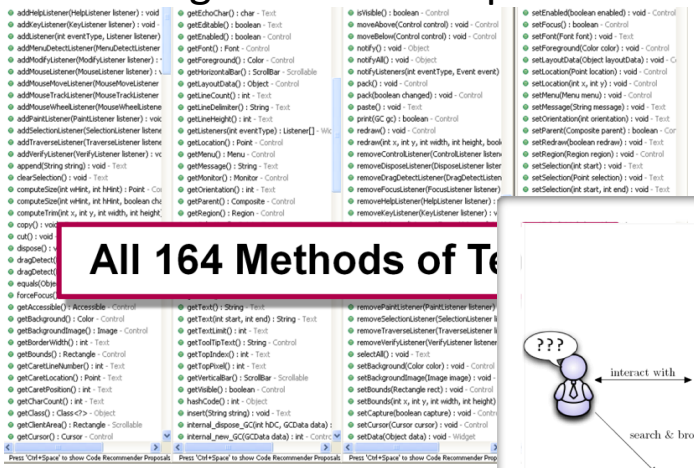
Jan Kassens, Peter Schroeder, Daniel Glöckner, Maik Görtz, Johannes Lerch, Johannes Born, Mohsen Parisay, Andreas Sewe, Sebastian Ahlfeld, Sebastian Kasten, Daniel Staesche, David Kalnischkies, Sebastian Wörner, Boyan Yurukov, Jan Stolzenburg, Nico Wombacher, Dirk Kröhan, Florianrian Jakob, Julius Rückert, Steffen Remus, Christopher Mann, Stefan Henss, Andreas Kaluza, Nikolay Shindov, Michael Novotny, Kristin Arand, Sinem Emeröz, Michael Kutschke, Sebastian Proksch, Tomasz Kalbarczyk, Marko Martin, Sheip Dargutev, David Schuld, Jens Krause, Kristijan Madunic, Daniel Brandtner, Roman Getto, Christian Kilb, Johannes Kastl, Dennis Sänger, Annie Liu, Markus Migenda, Tjark Vandommele, Sebastian Denel, Florian Nöll, Gary Fritz, Dennis Siebert, Peter Sinzig, Laura Altmüller, Paul Schatygin, Jan-Michael Heller, Minh Hoang Nguyen, Sascha Nordquist, Paul Emmanuel Faidherbe, ...

Q & A



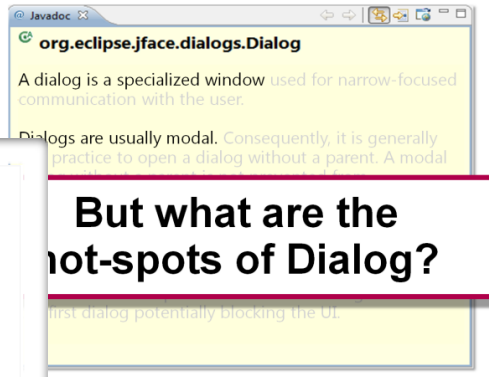
Q & A

Intelligent Code Completion



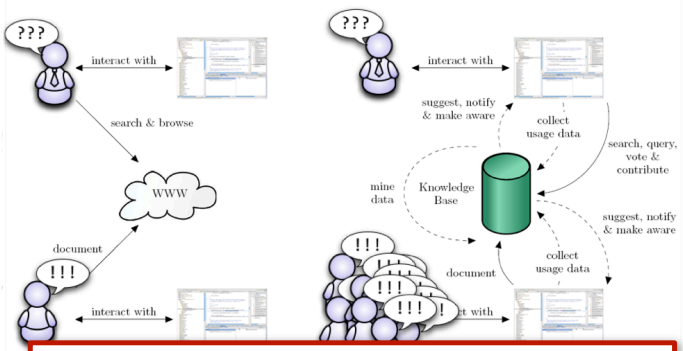
All 164 Methods of Te

Usage-Driven Javadocs



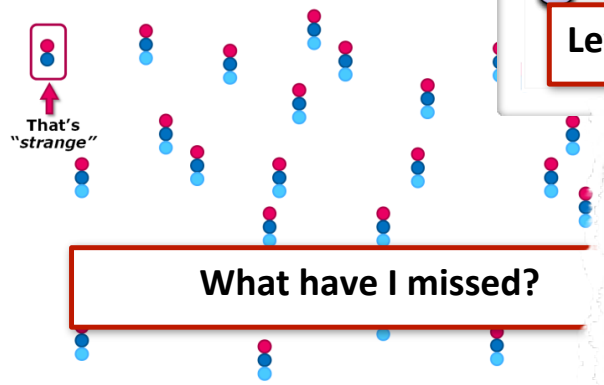
But what are the hot-spots of Dialog?

From IDE 1.0 to IDE 2.0



Leverage the Wisdom of the Crowds!

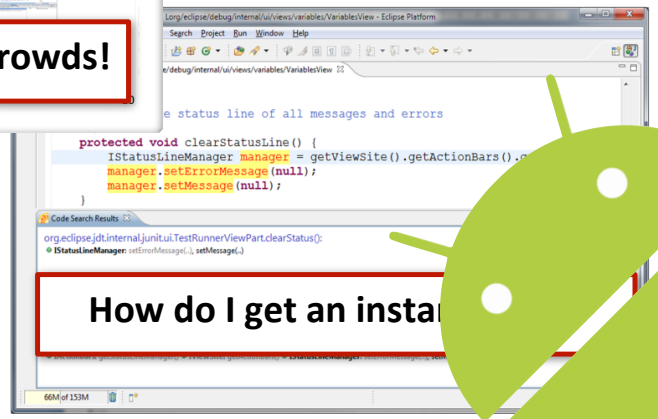
Smart Bug Detectio



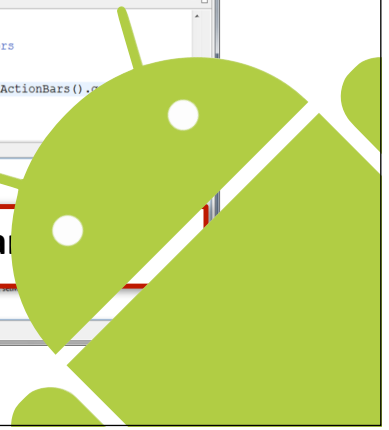
What have I missed?

X=

Example Recommender



How do I get an insta



It’s there.

http://eclipse.org/recommenders/

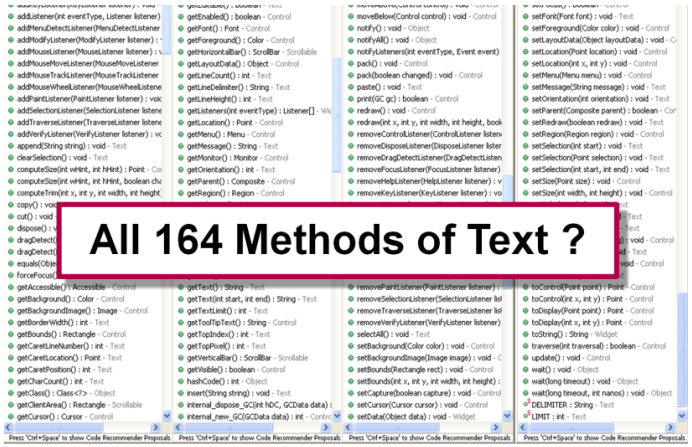
Follow me on twitter: @MarcelBruch
google+: +Marcel Bruch

“People that ~~bought~~ had this NullPointerException, made this mistake:...”

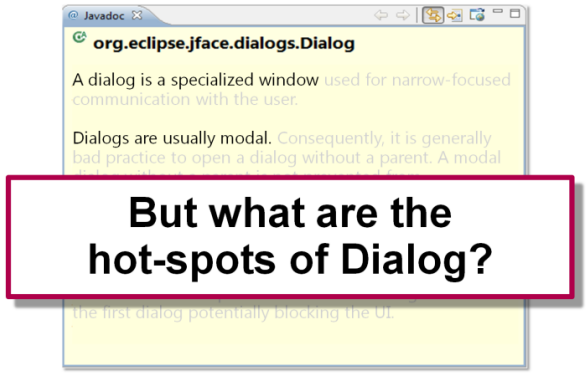
WHAT CAUSED THAT STACKTRACE?

So far we have…

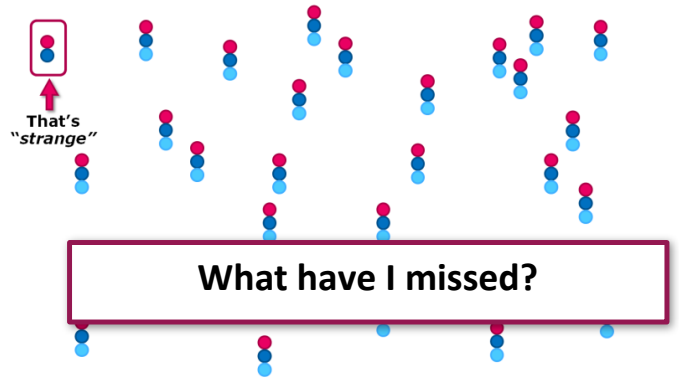
Intelligent Code Completion



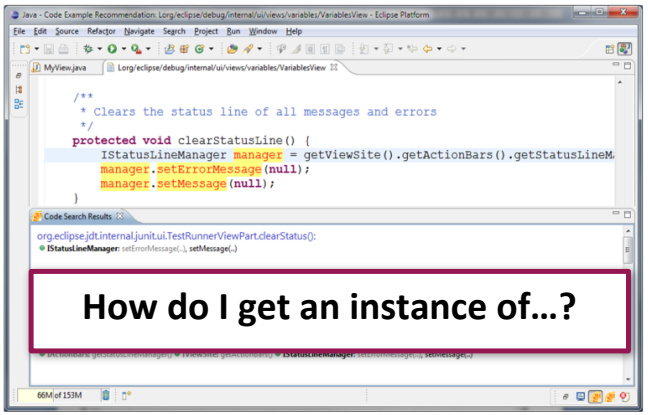
Extended Documentation



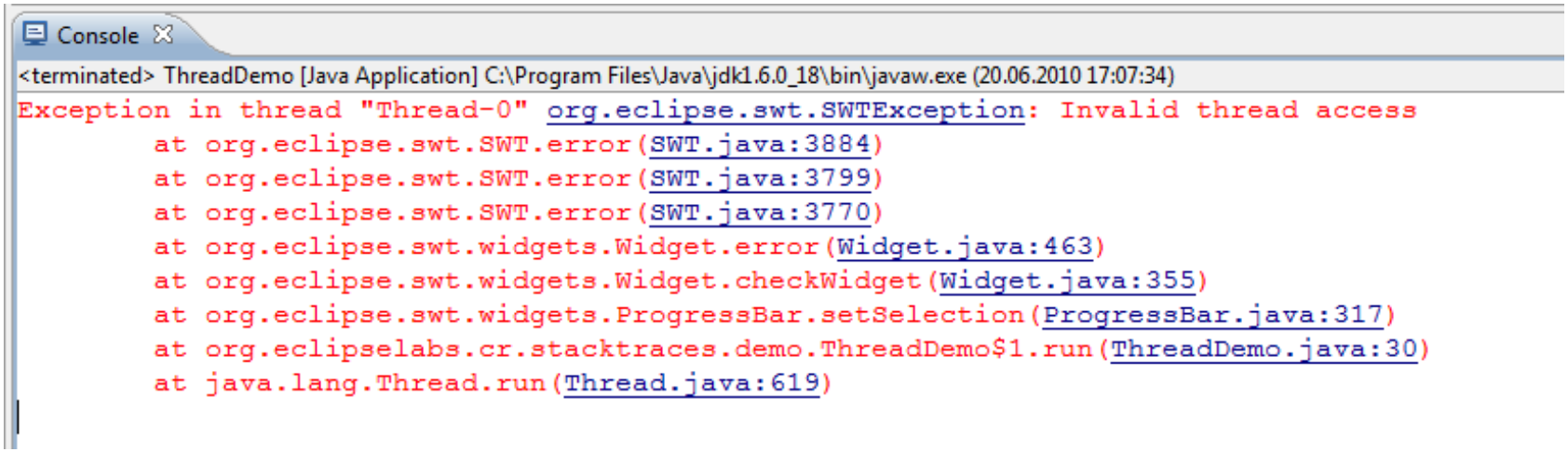
Smart Bug Detection



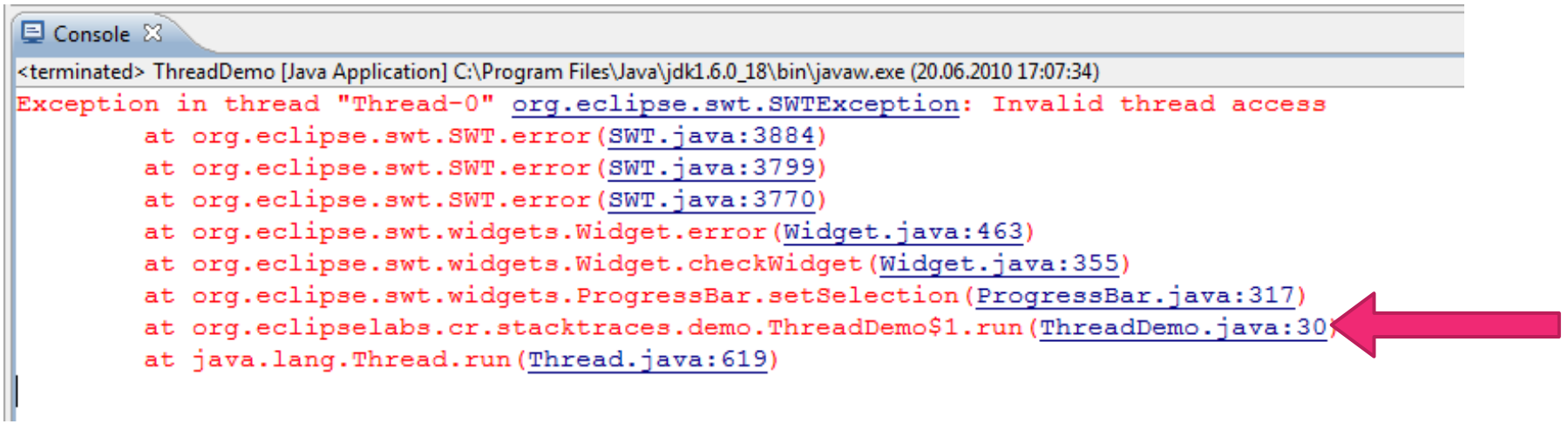
Code Example Recommender



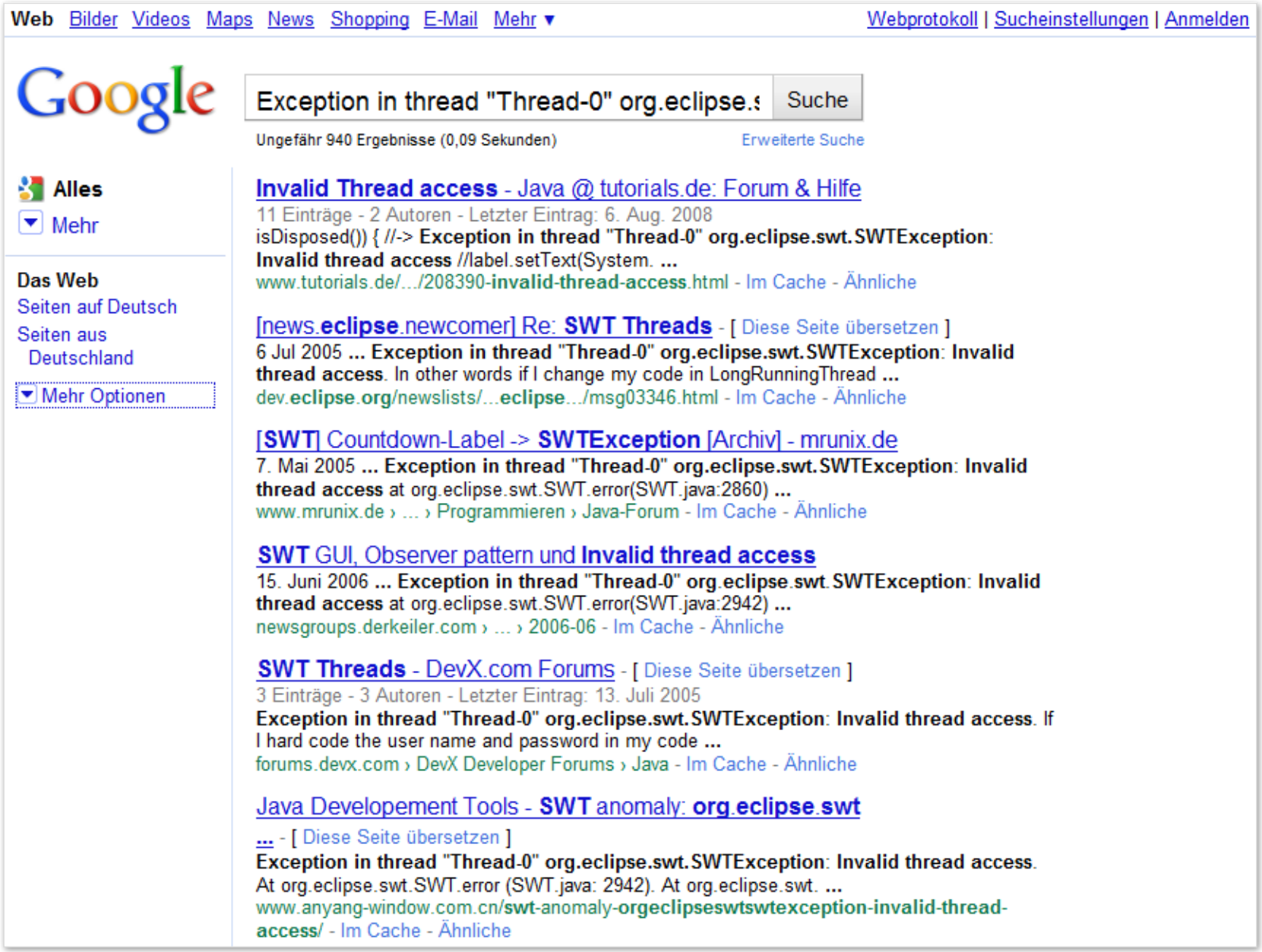
But what if you get this?



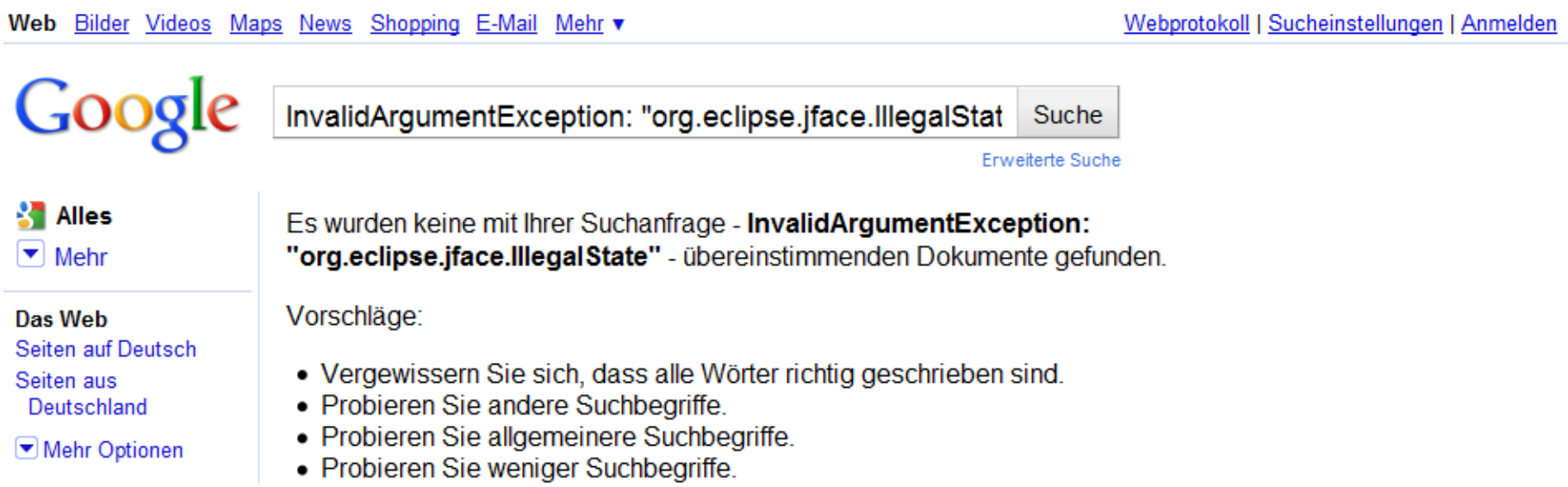
Debugging – the old way



Debugging – the old way



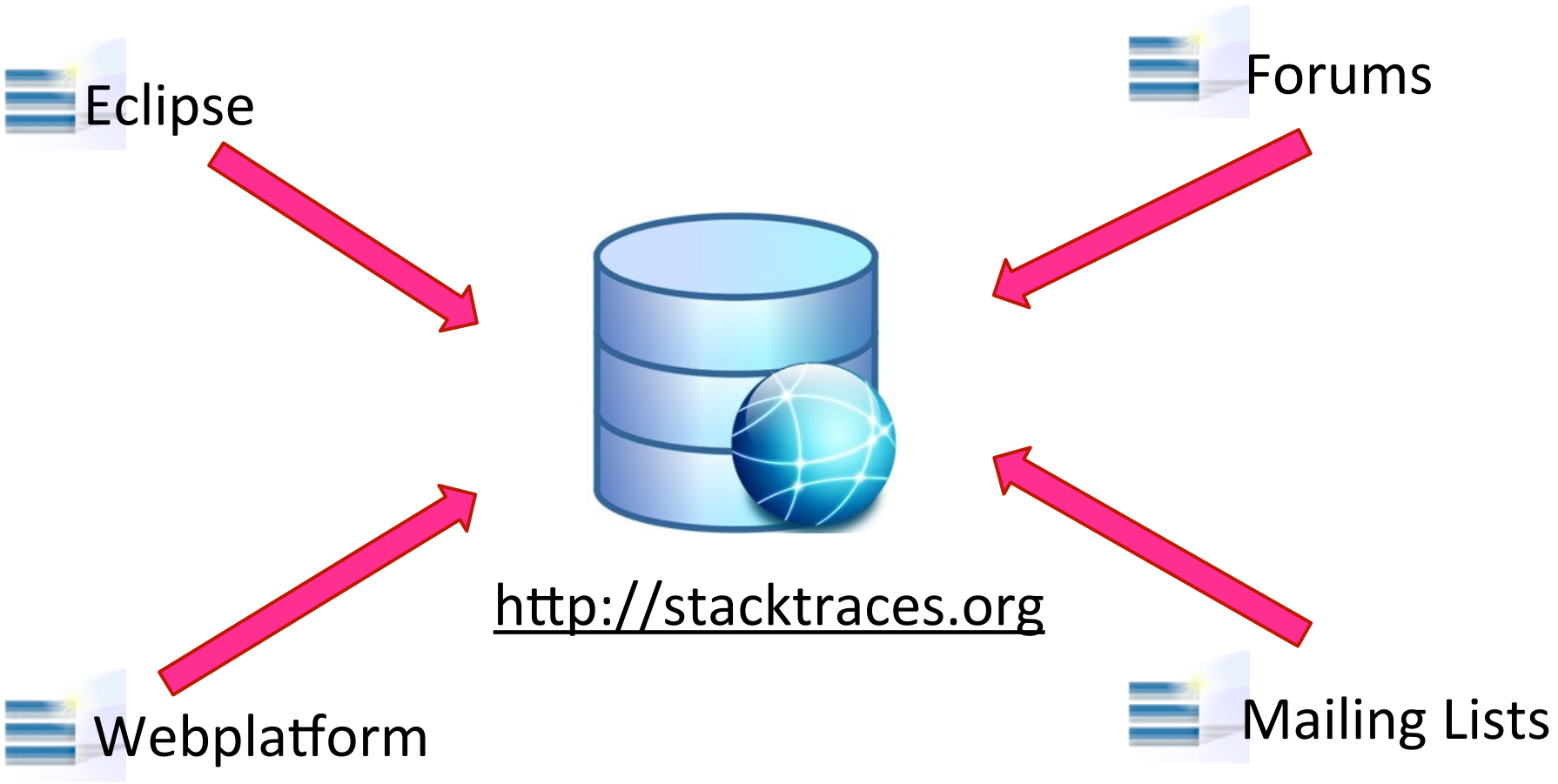
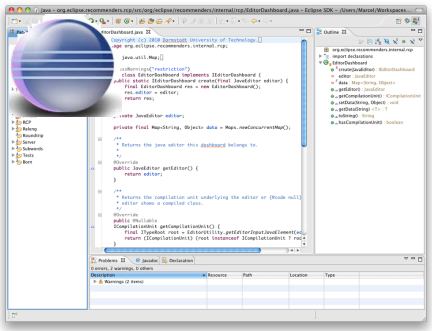
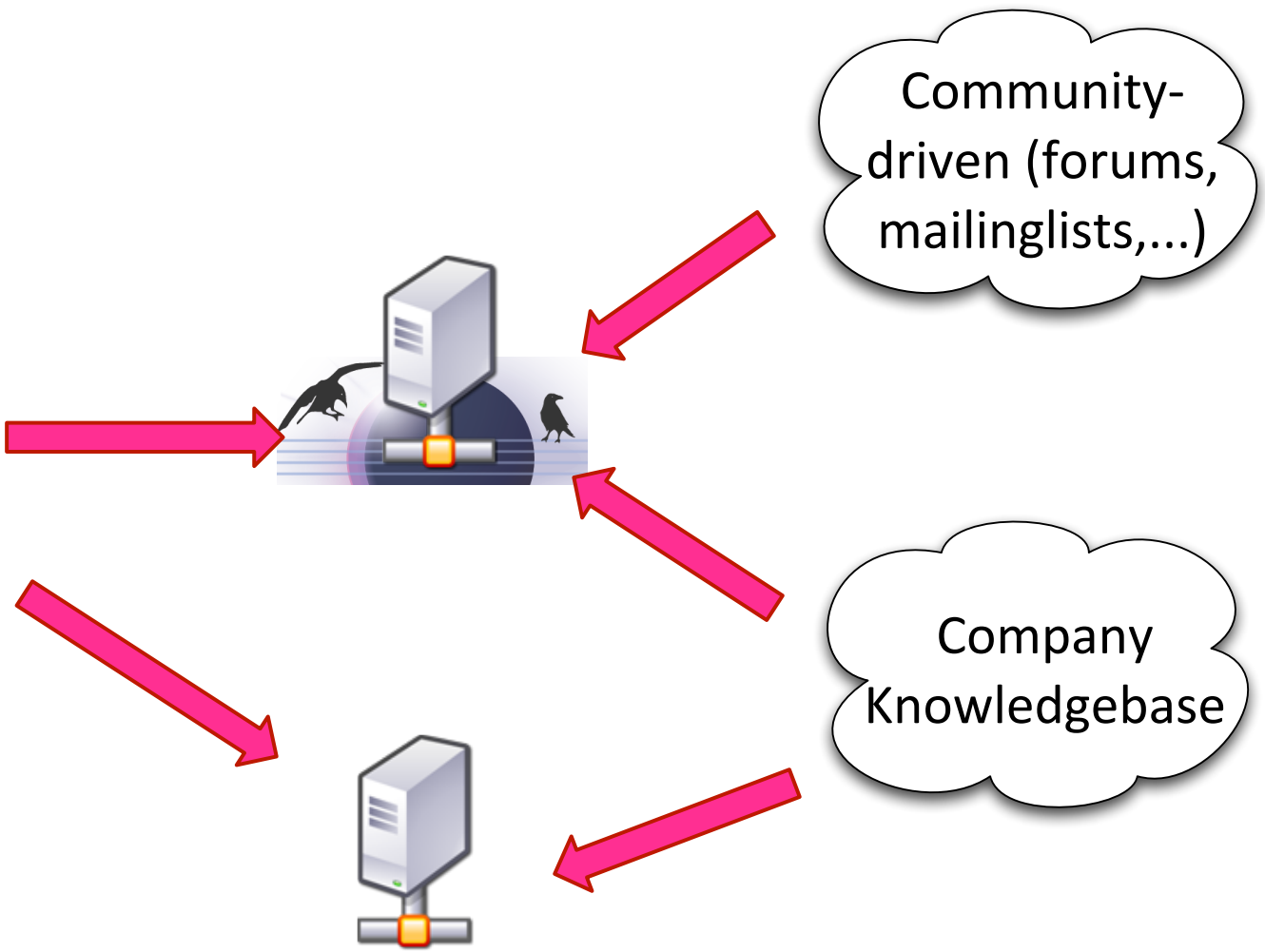
But more often we get…



How can we fix that?
Don’t stacktraces share some commonalities?

How about stacktraces.org?

Knowledge sources



Application scenarios for your company