

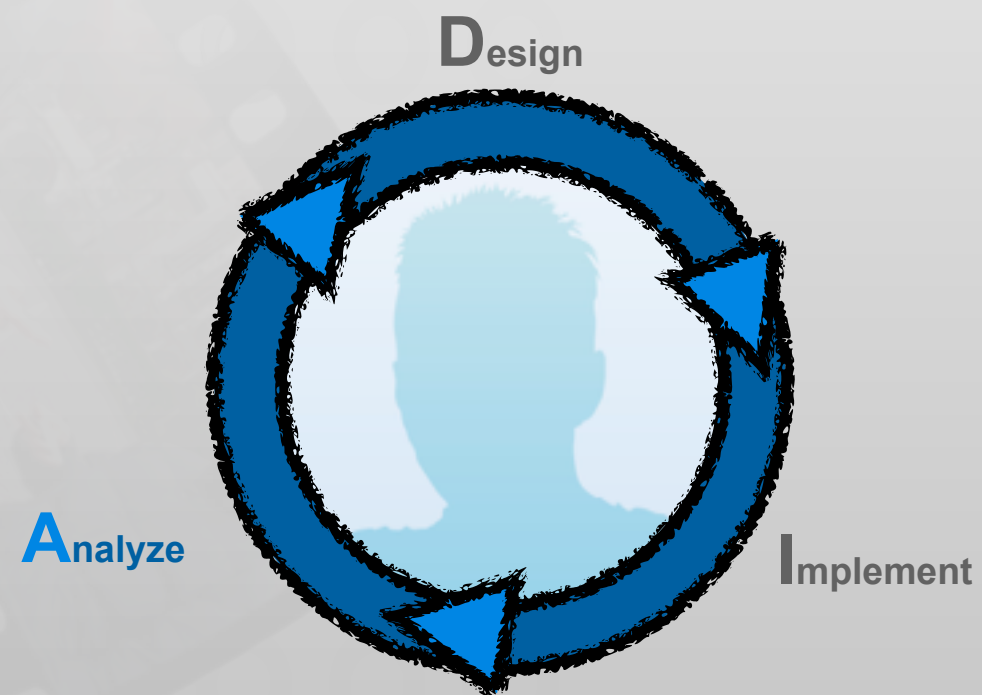
# Research in Coding and IDEs

*Jan-Peter Krämer  
Media Computing Group  
RWTH Aachen University*

<http://hci.rwth-aachen.de/cthci>



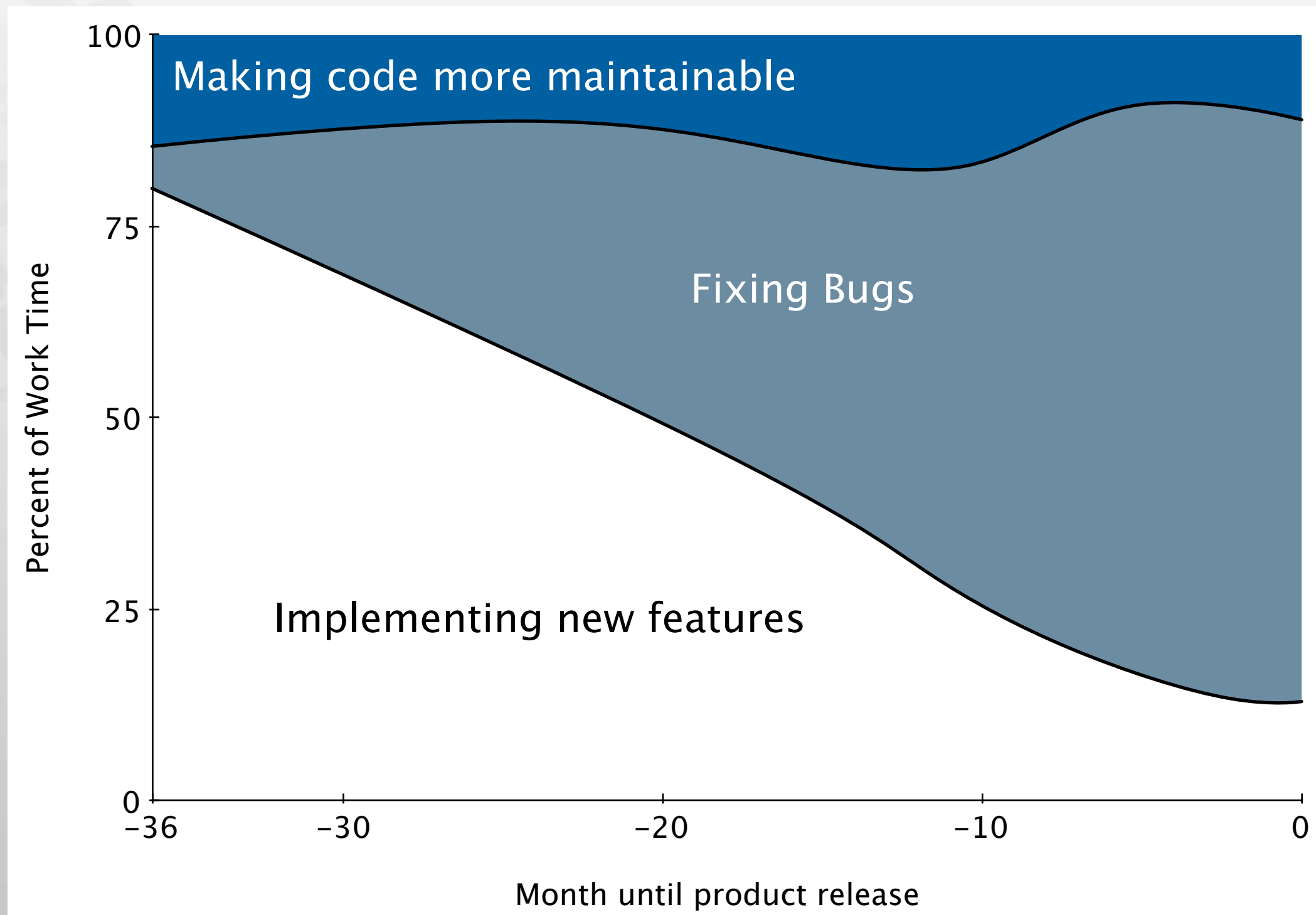
# Status Quo

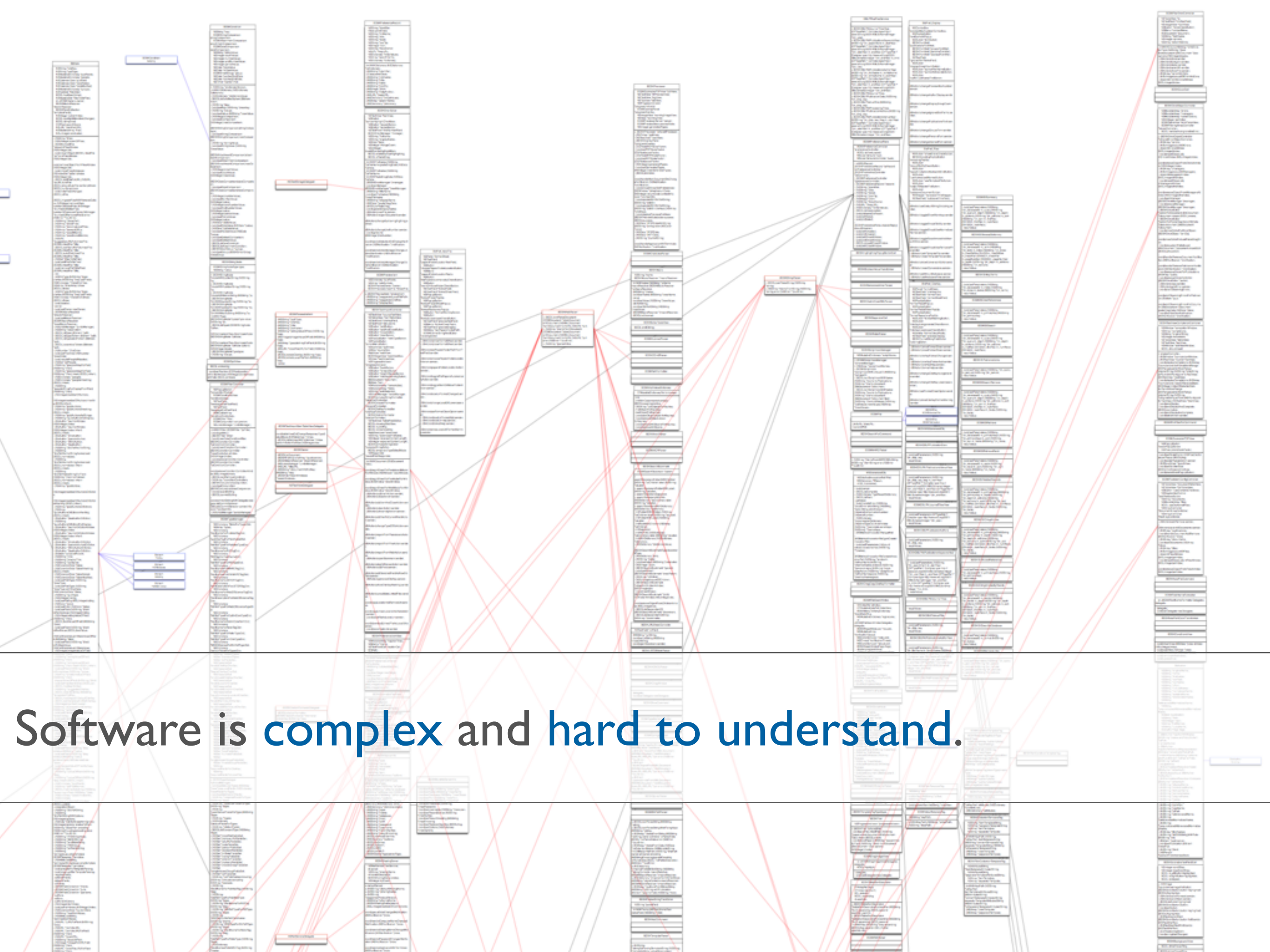




# Time in Software Development

[LaToza2006, Maintaining mental models: a study of developer work habits]





Software is **complex** and hard to understand.



# Task context

- What is relevant information?
- What strategies are applied to find information?

# Models for Developer Strategies

[Ko2006, An Exploratory Study of How Developers Seek, Relate, and Collect Relevant Information during Software Maintenance Tasks]



31 Professional Java Developers



5 Maintenance tasks  
(3 Bugs, 2 Enhancements)



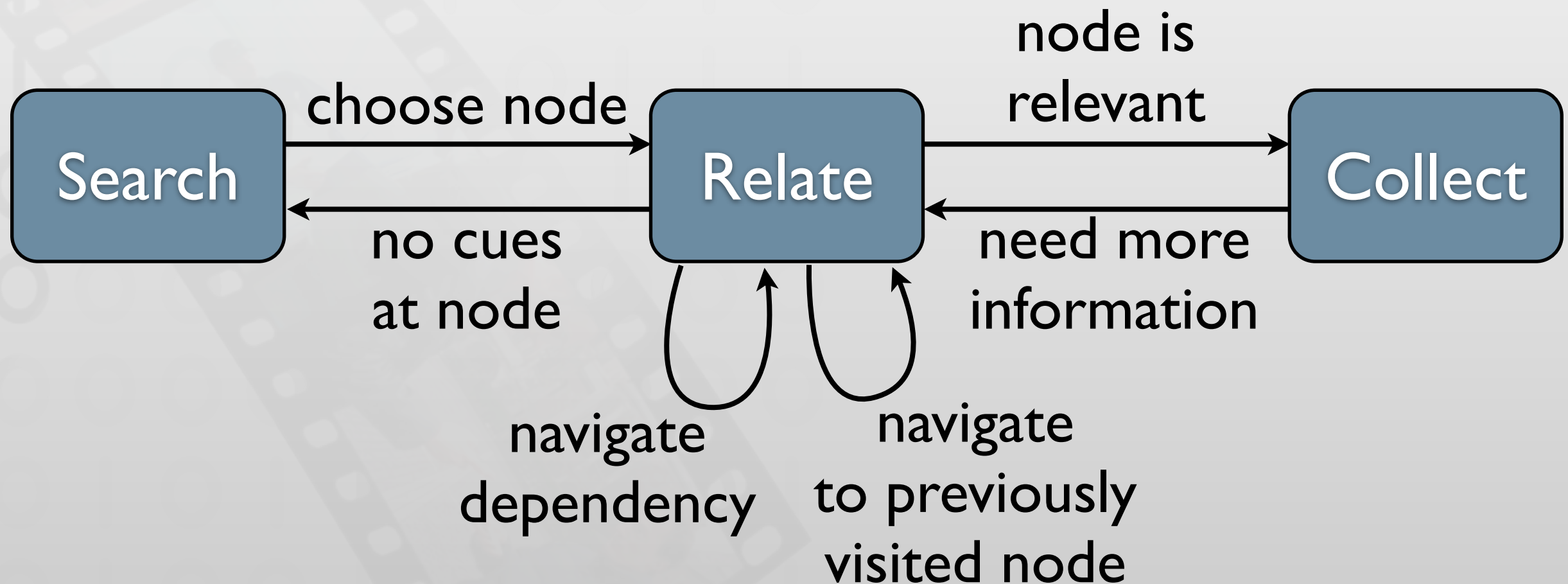
500 SLOC Java Paint  
Application





# Models for Developer Strategies

[Ko2006, An Exploratory Study of How Developers Seek, Relate, and Collect Relevant Information during Software Maintenance Tasks]

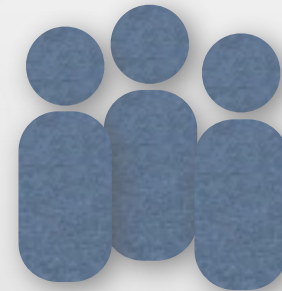


# Models for Developer Strategies

[Sillito2008, Asking and Answering Questions during a Programming Change Task]



9 experienced developers (pair programming)



16 developers from industry



1 of 5 maintenance tasks per session



Real world change task



ArgoUML  
60k SLOC

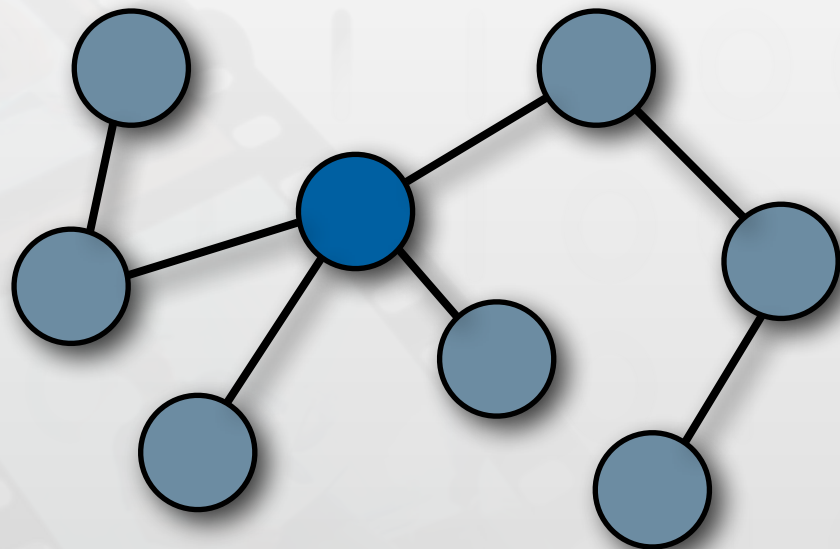


Real world sour code

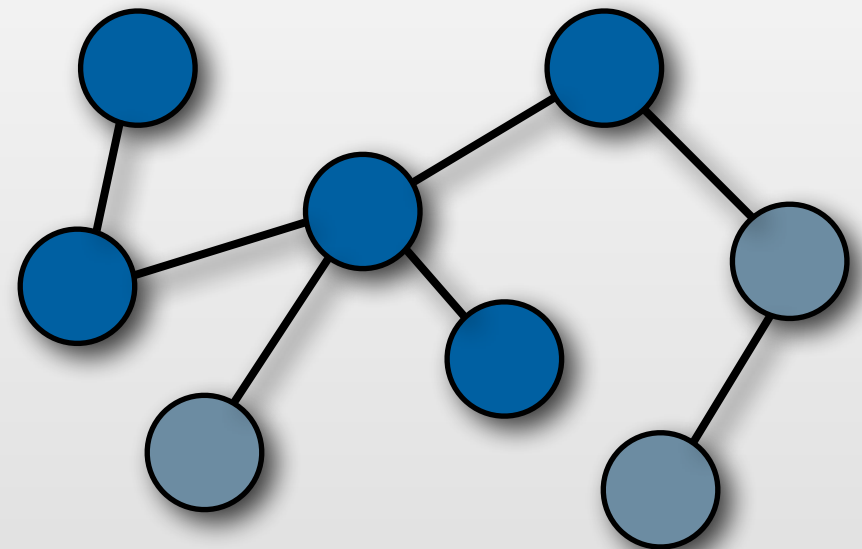


# Models for Developer Strategies

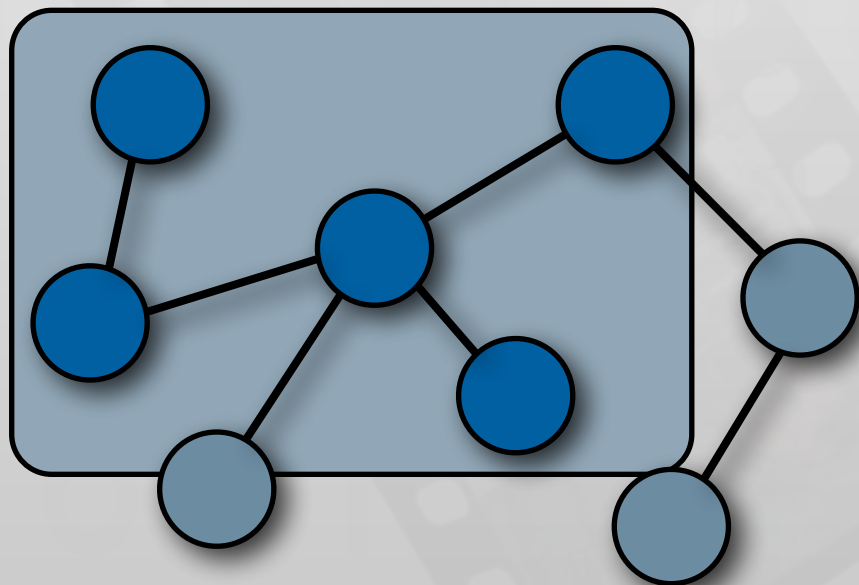
[Sillito2008, Asking and Answering Questions during a Programming Change Task]



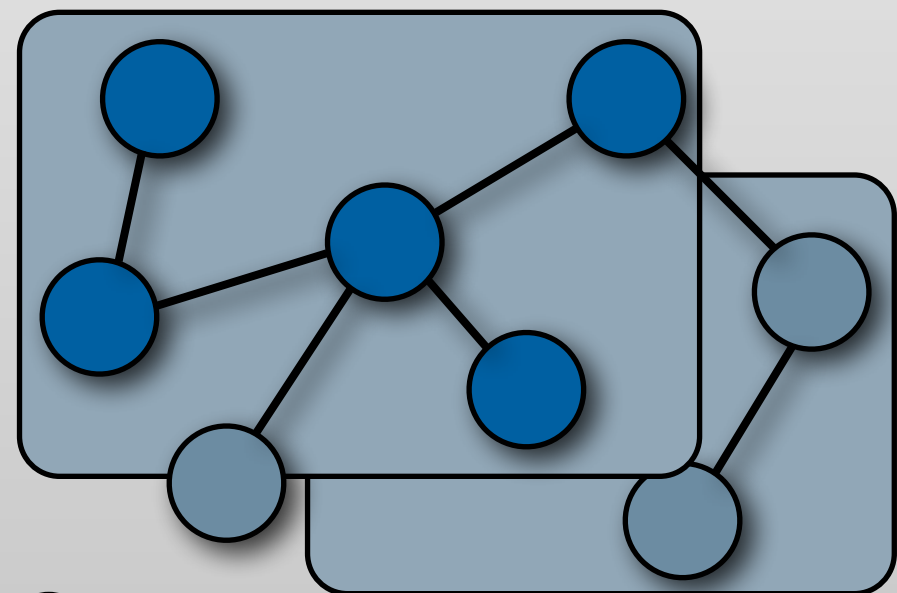
Finding focus points



Expanding focus points



Understanding a subgraph



Questions over groups of subgraphs





Java - jHotDraw/src/org/jhotdraw/contrib/DesktopEvent.java Eclipse SDK - /Users/jpkraemer/Downloads/jhotdraw60b1

Package Explorer: jHotDraw

- src
  - org.jhotdraw
    - org.jhotdraw.applet
    - org.jhotdraw.application
    - org.jhotdraw.contrib
      - org.jhotdraw.contrib.dnd
      - org.jhotdraw.contrib.html
      - org.jhotdraw.contrib.zoom
    - org.jhotdraw.figures
    - org.jhotdraw.framework
    - org.jhotdraw.images
    - org.jhotdraw.samples
      - org.jhotdraw.samples.javadraw
        - AnimationDecorator.java
        - Animator.java
        - BouncingDrawing.java
        - FollowURLTool.java
        - JavaDrawApp.java
        - JavaDrawApplet.java
        - JavaDrawViewer.java
        - MySelectionTool.java
        - PatternPainter.java
        - URLTool.java
        - JavaDrawAppletHelp.html
      - org.jhotdraw.samples.javadraw.sam
      - org.jhotdraw.samples.minimap
      - org.jhotdraw.samples.net
      - org.jhotdraw.samples.nothing
      - org.jhotdraw.samples.pert
      - org.jhotdraw.samples.pert.images
      - org.jhotdraw.standard
      - org.jhotdraw.test
      - org.jhotdraw.test.contrib
      - org.jhotdraw.test.figures
      - org.jhotdraw.test.framework
      - org.jhotdraw.test.samples.javadraw
      - org.jhotdraw.test.samples.minimap
      - org.jhotdraw.test.samples.net
      - org.jhotdraw.test.samples.nothing
      - org.jhotdraw.test.samples.pert
      - org.jhotdraw.test.standard
      - org.jhotdraw.test.util
      - org.jhotdraw.test.util.collections.jdk
      - org.jhotdraw.test.util.collections.jdk
      - org.jhotdraw.util
      - org.jhotdraw.util.collections.jdk11
      - org.jhotdraw.util.collections.jdk12

JRE System Library [JavaSE-1.6]

DesktopEvent.java

```
@(#)DesktopEvent.java

package org.jhotdraw.contrib;

import org.jhotdraw.framework.DrawingView;

/**
 * @author C.L.Gilbert <dnoyeb@users.sourceforge.net>
 * @version <CURRENT_VERSION$>
 */
public class DesktopEvent extends EventObject {
    private DrawingView myDrawingView;

    /**
     * Some events require the previous DrawingView (e.g. when a new DrawingView
     * is selected).
     */
    private DrawingView myPreviousDrawingView;

    public DesktopEvent(Desktop newSource, DrawingView newDrawingView) {
        this(newSource, newDrawingView, null);
    }

    public DesktopEvent(Desktop newSource, DrawingView newDrawingView, DrawingView newPreviousDV) {
        super(newSource);
        setDrawingView(newDrawingView);
        setPreviousDrawingView(newPreviousDV);
    }

    private void setDrawingView(DrawingView newDrawingView) {
        myDrawingView = newDrawingView;
    }

    public DrawingView getDrawingView() {
        return myDrawingView;
    }

    private void setPreviousDrawingView(DrawingView newPreviousDrawingView) {
        myPreviousDrawingView = newPreviousDrawingView;
    }

    public DrawingView getPreviousDrawingView() {
        return myPreviousDrawingView;
    }
}
```

Outline: org.jhotdraw.contrib

- import declarations
- DesktopEvent
  - myDrawingView : DrawingView
  - myPreviousDrawingView : DrawingView
  - DesktopEvent(Desktop, DrawingView)
  - DesktopEvent(Desktop, DrawingView, DrawingView)
  - setDrawingView(DrawingView) : void
  - getDrawingView() : DrawingView
  - setPreviousDrawingView(DrawingView) : void
  - getPreviousDrawingView() : DrawingView

Problems: Javadoc Declaration Call Hierarchy

Calls from 'DesktopEvent(Desktop, DrawingView, DrawingView)' - in workspace

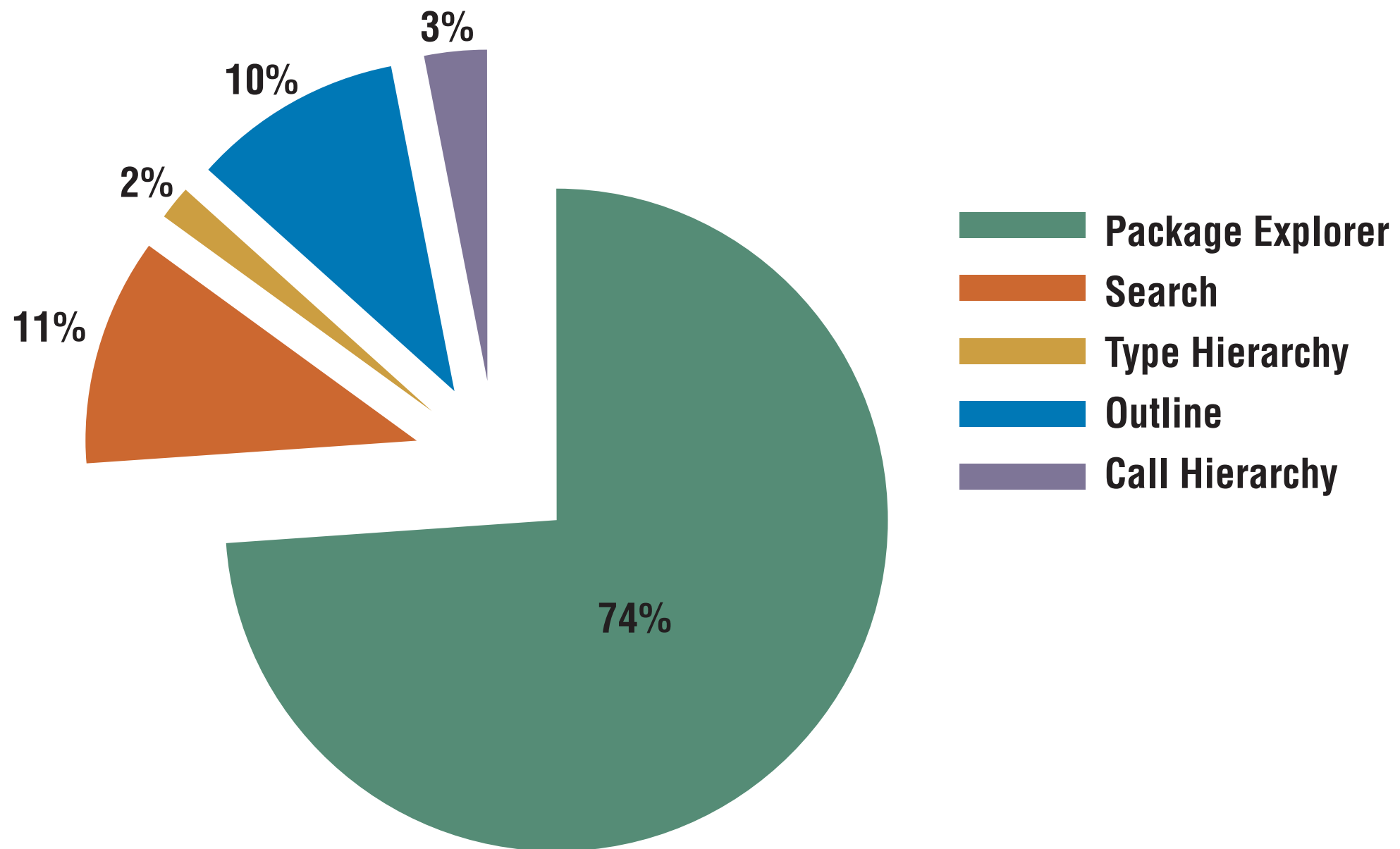
- DesktopEvent(Desktop, DrawingView, DrawingView) - org.jhotdraw.contrib.DesktopEvent
  - EventObject(Object) - java.util.EventObject
  - setDrawingView(DrawingView) : void - org.jhotdraw.contrib.DesktopEvent
  - setPreviousDrawingView(DrawingView) : void - org.jhotdraw.contrib.DesktopEvent

org.jhotdraw.samples.javadraw.Animator.java - jHotDraw/src

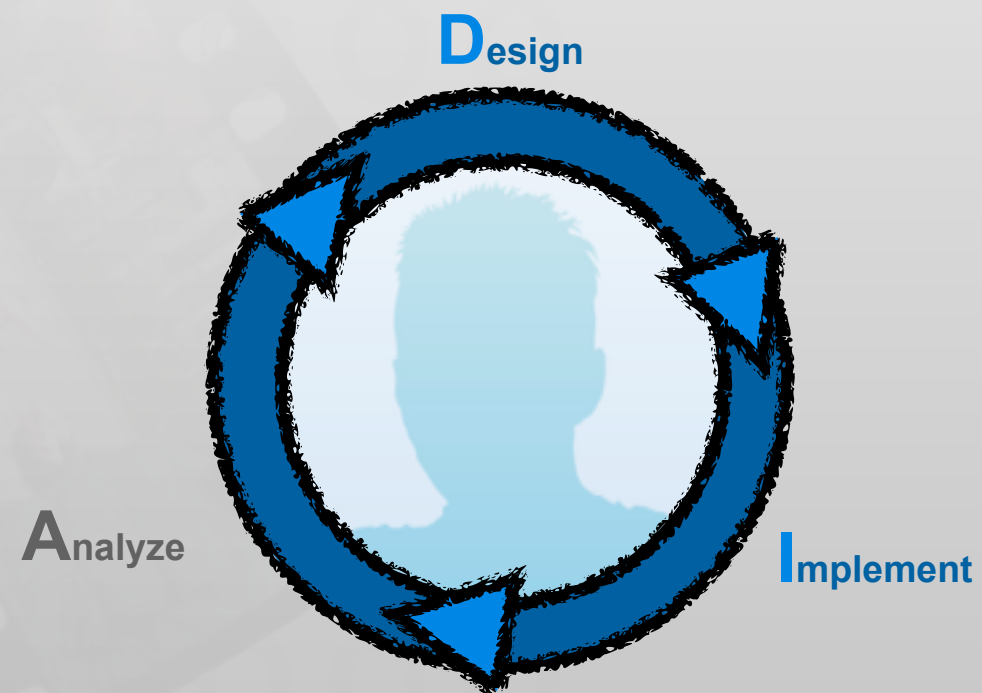


# Tools Used in Eclipse

[Murphy2006, How Are Java Software Developers Using the Eclipse IDE?]



# Easing Access to Task Context



Java - Attach error log entries into new bug reports - Eclipse SDK

File Edit Navigate Search Project Run Window Help

Package Exp Hierarchy BugzillaAttributeMapper.java \*216640: Attach error log entries into new bug r

### Bug 216640

Attach error log entries into new bug reports

P5 Status: NEW Bug: 216640 Opened: Jan 25, 2008 Modified: Jan 29, 2008 2:32 AM

Attributes Attachments (0) Description

Comments (1)

1: Mik Kersten, Jan 29, 2008 1:54 AM

New Comment

Looking into this now, see also related [bug 124224](#).

Actions

- ☐ Leave as NEW
- ☐ Accept (change status to ASSIGNED)
- ☐ Resolve as
- ☐ Duplicate of
- ☒ Reassign to - ☐ Reassign to default

Submit

People

Assigned to: Mylyn Inbox <mylyn-inbox@e

Reporter: William Mitsuda <wmitsuda@g

QA Contact:

Add CC:

jacek.pospychala@pl.ibm.com  
mik.kersten@tasktop.com

(Select to remove)

Task List

Find:  All Allow to ed...

- Mylyn - Mik [Bugzilla]
  - 162335: [context] Allow "Make Landi
  - 267524: create Mylyn 3.2 release plan
- Mylyn - Rob [Bugzilla]
  - 124224: Allow to edit priorities in
- Project - Steffen [Trac]
  - 83: filter sort results
  - 84: upgrade ws api
  - 5: address web site nits
- Target - Rob [Atlassian]
  - PLE-290: logged in as wrong user wh
  - PLE-327: Documentation for Eclipse
  - PLE-172: Create Crucible review with
  - PLE-238: add an action to a cha

Synchronize

Change Sets for CVS (Workspace)

Allow to edit priorities in the task list

> org.eclipse.mylyn.bugzilla.core [dev

streamline task attachments

Planning Context Bugzilla

[Kersten2006, Using Task Context to Improve Programmer Productivity]



# Recommender Tools

[Singer2005, NavTracks: supporting navigation in software maintenance]

[DeLine2005, Easing program comprehension by sharing navigation data]

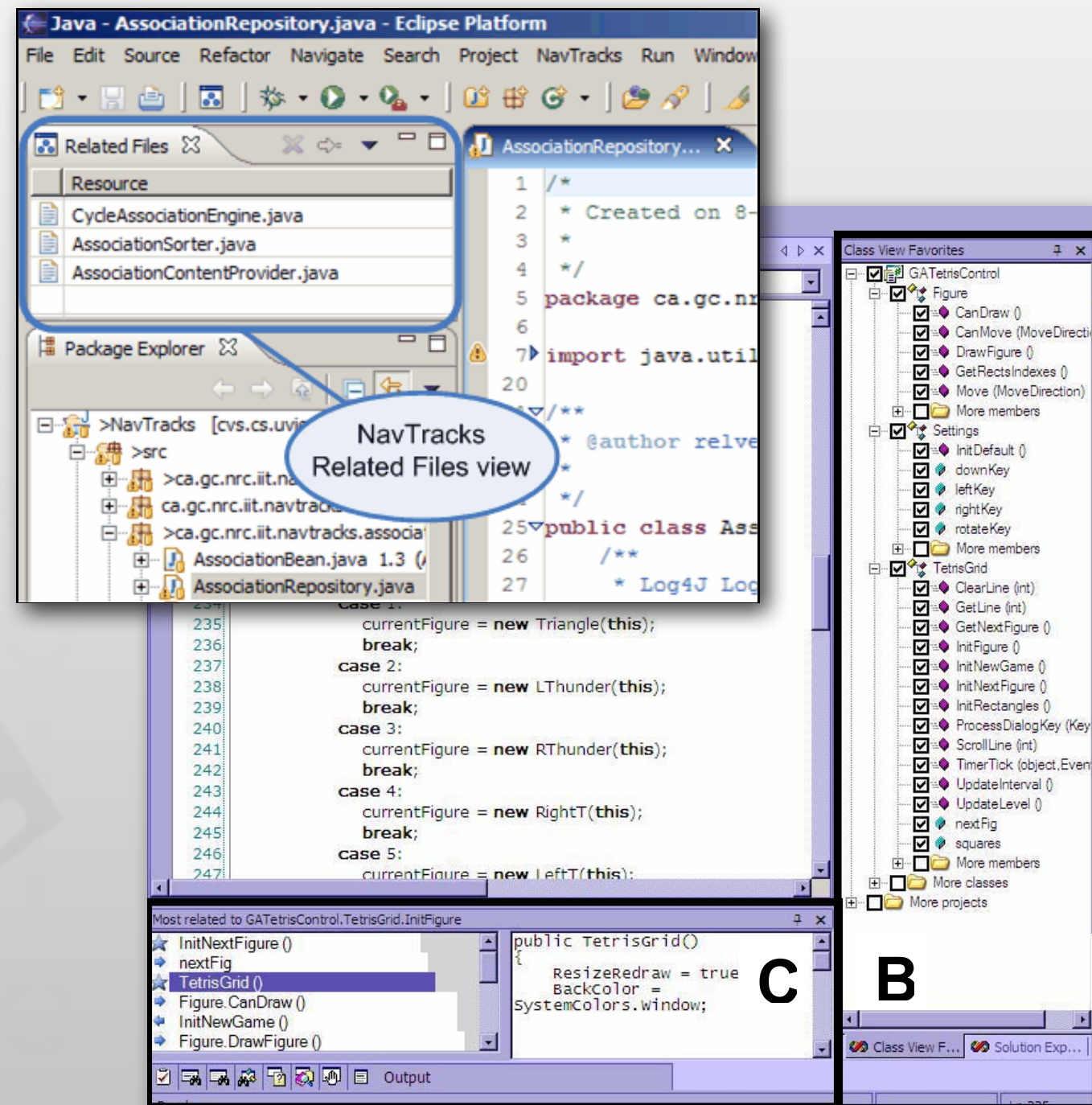
[Čubranic'2005, Hipikat: recommending pertinent software development artifacts]

- Calculate a Degree of Interest for source code elements based on:

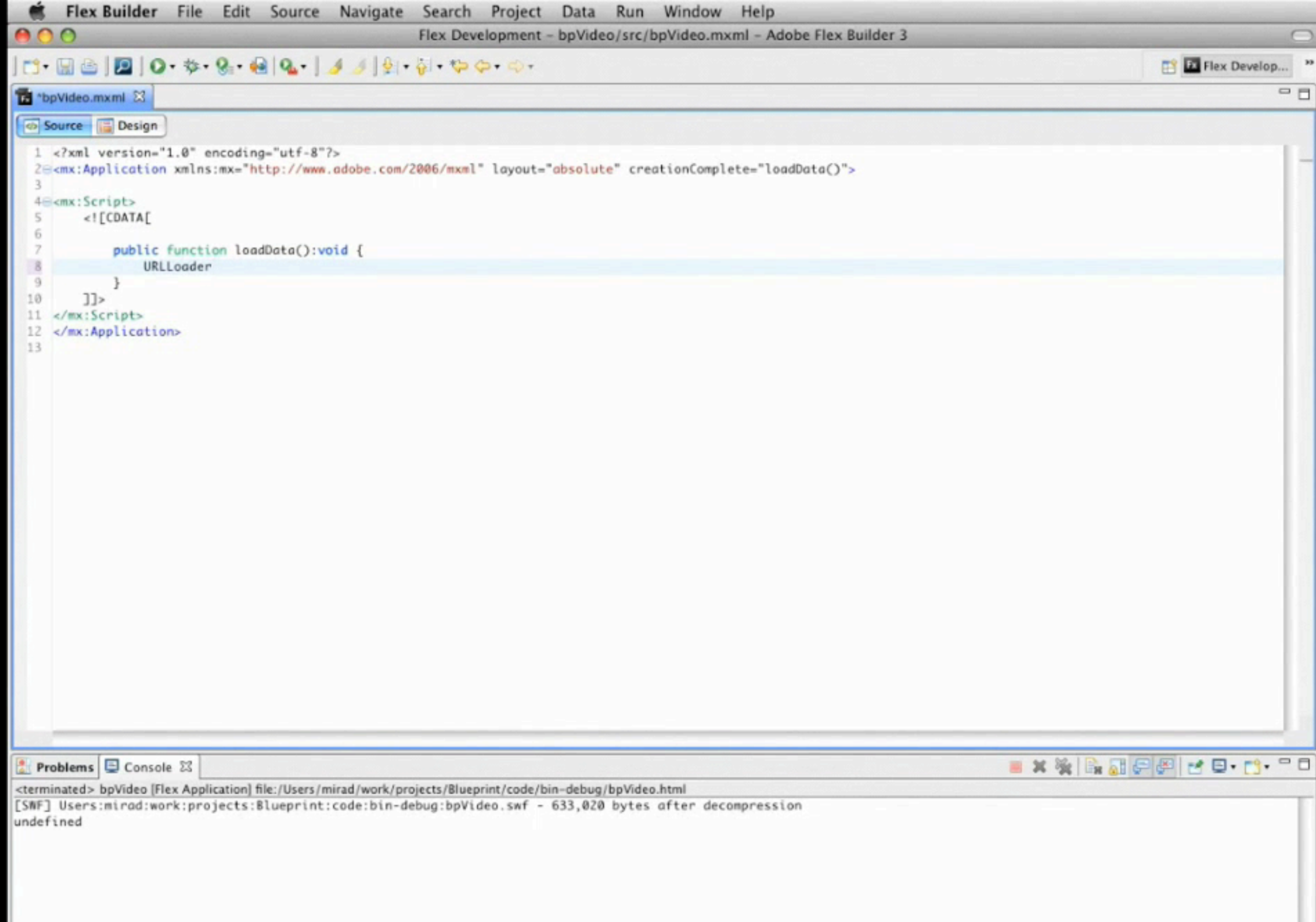
- reading history
- editing history
- history of other team members
- information from version control systems

- Remaining Problems:

- Still only text-based visualization
- Recommendations for irrelevant code are still irrelevant



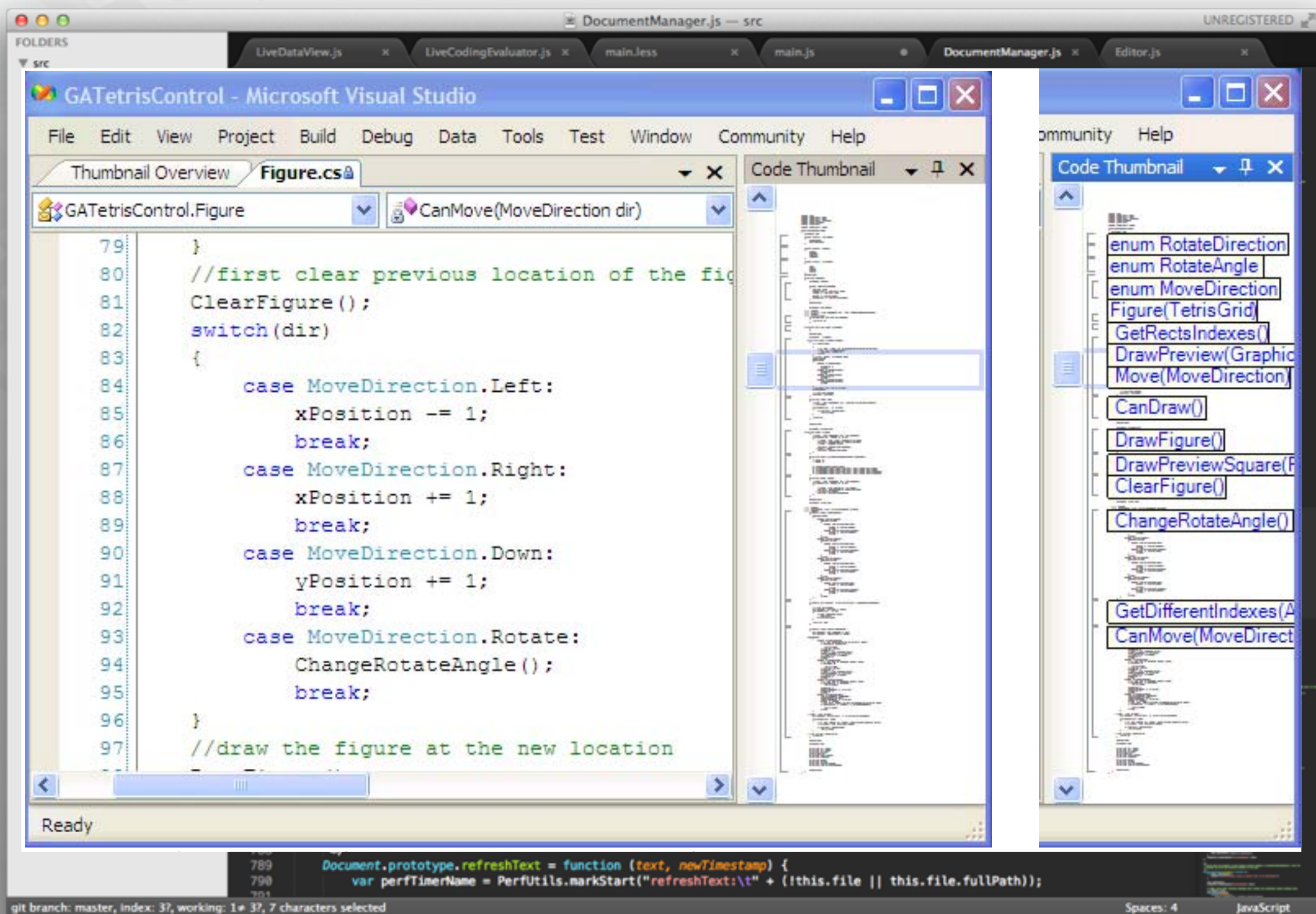


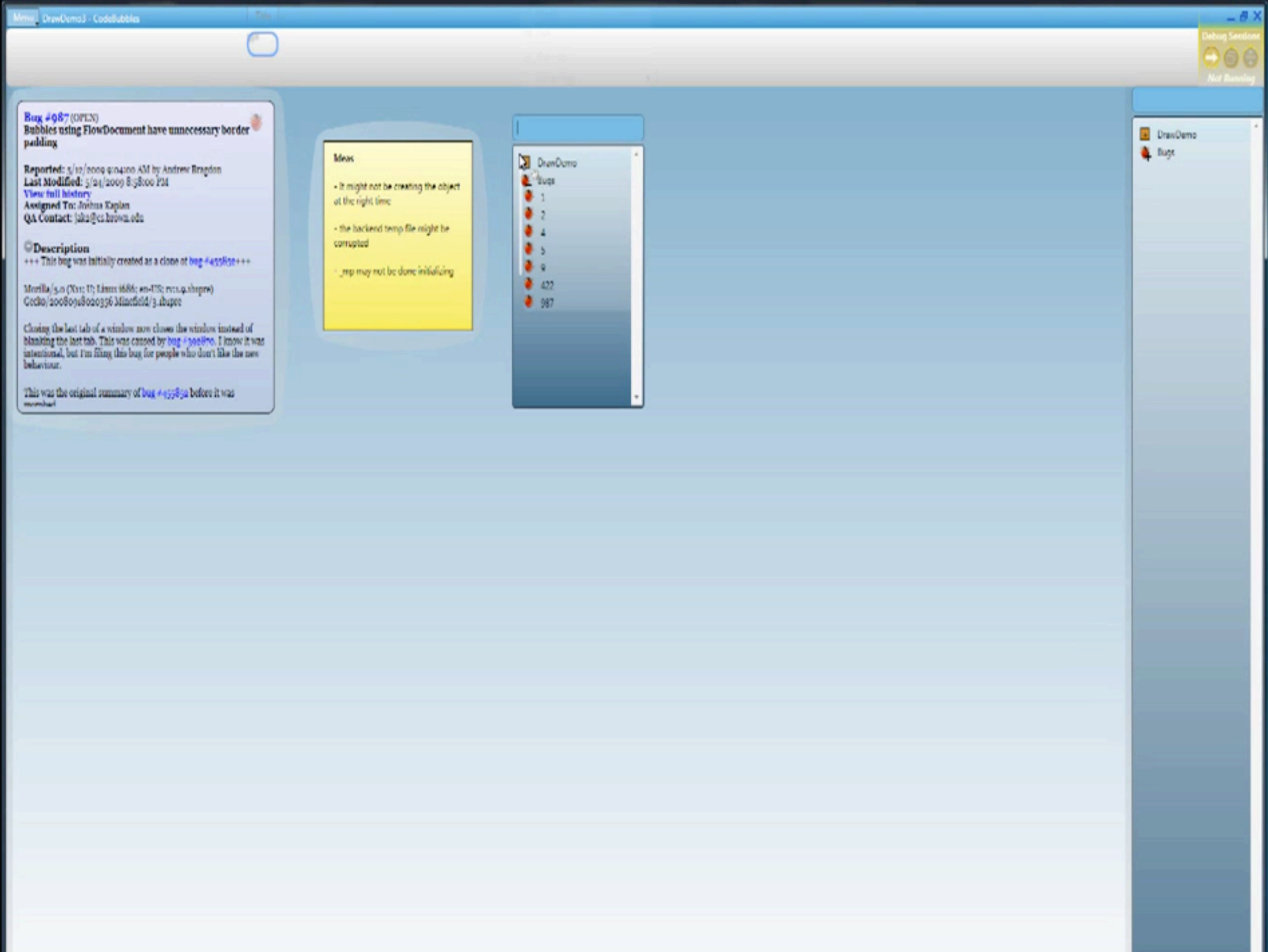


[Brandt2010, Example-centric programming: integrating web search into the development environment]

# Changing the Presentation

[DeLine2006, CodeThumbnails2, Using Special Memory to Navigate Source Code]





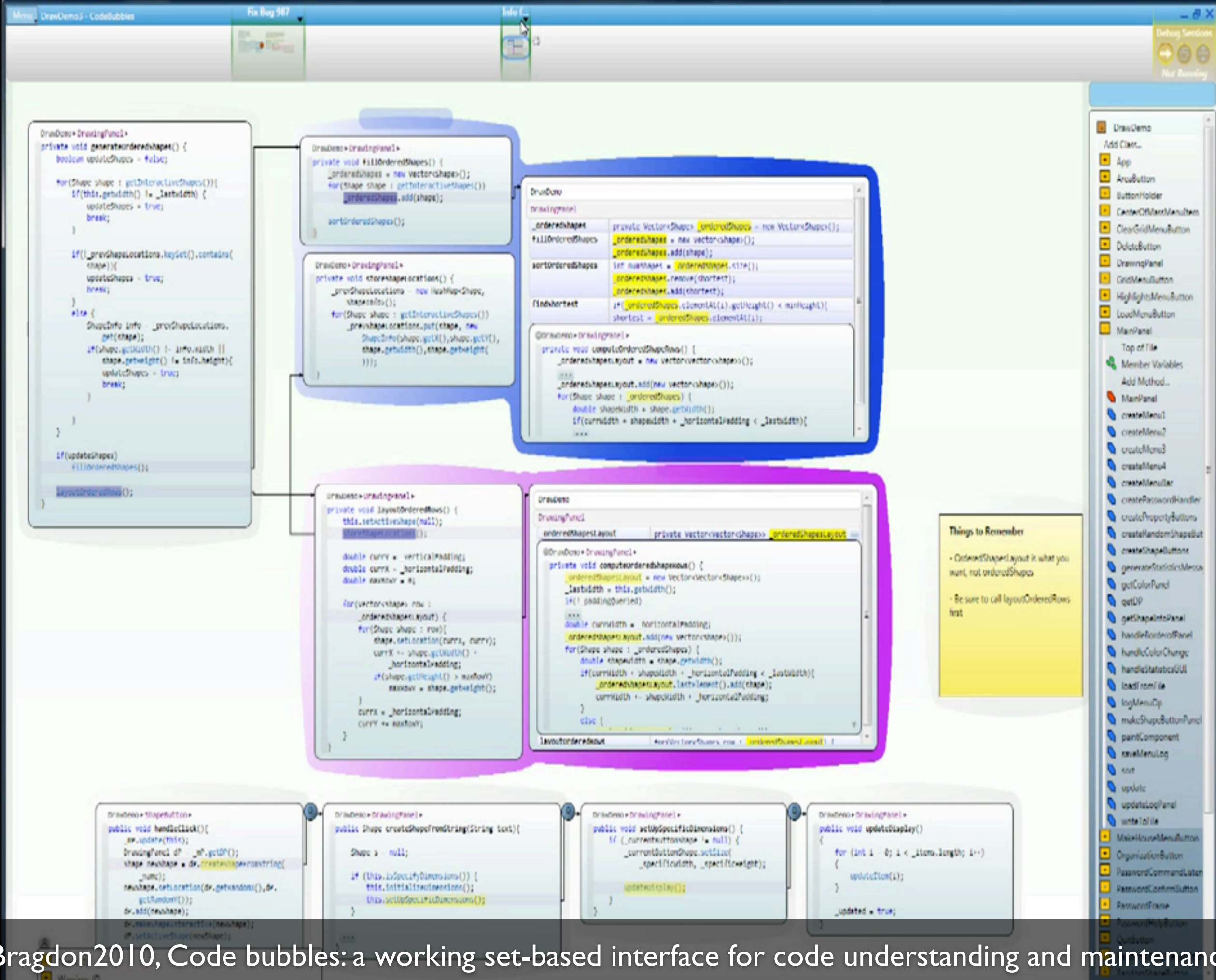


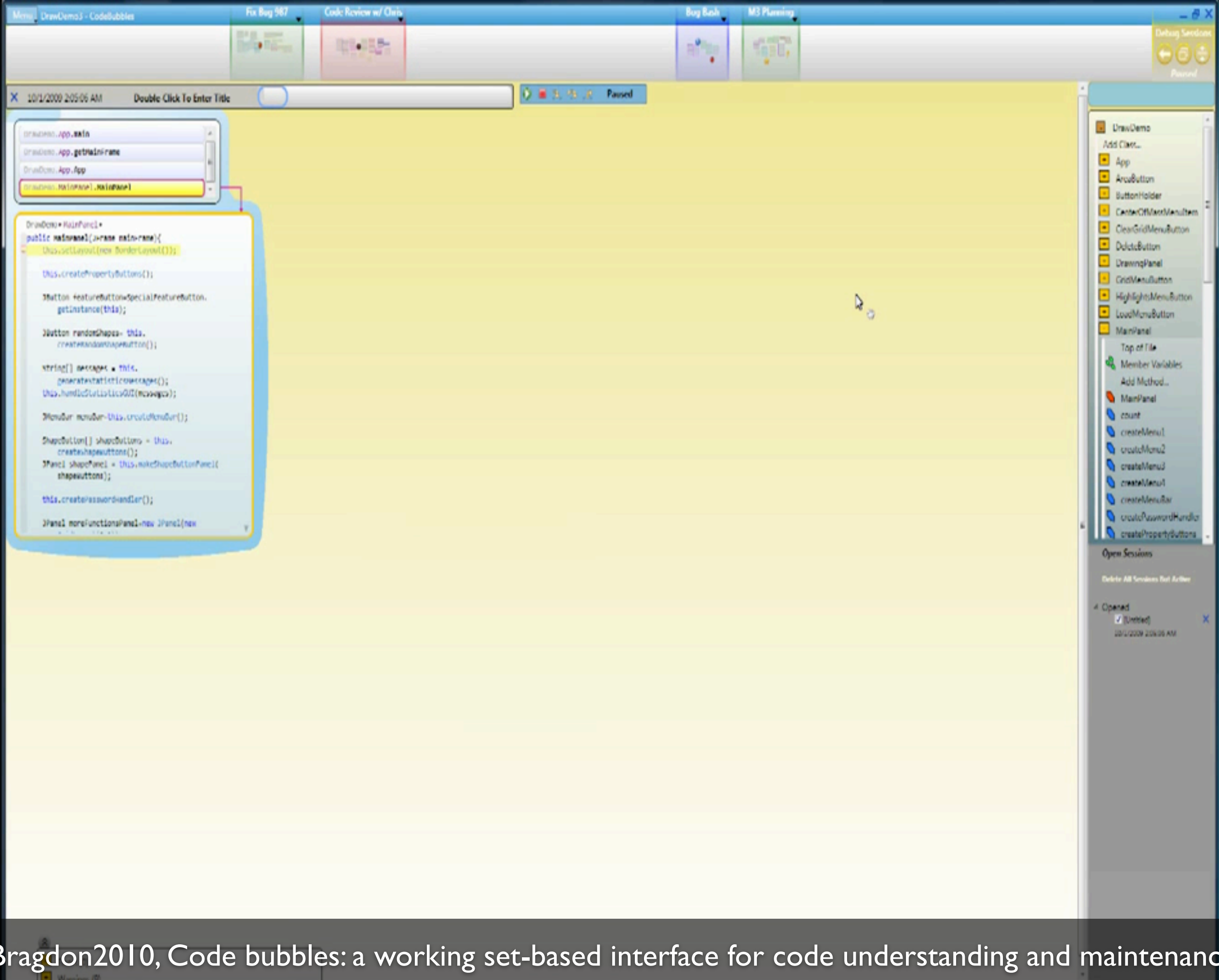










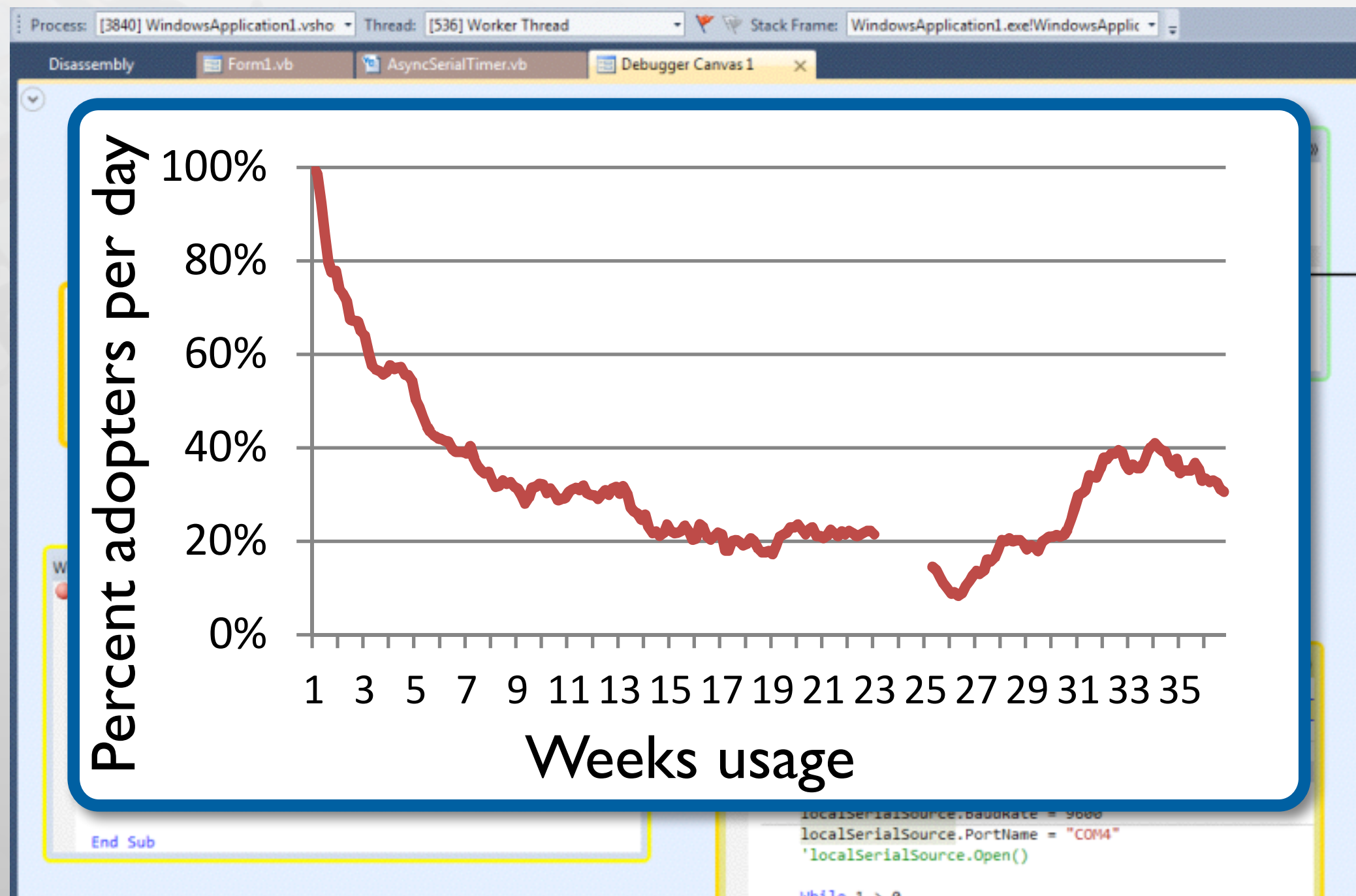


[Bragdon2010, Code bubbles: a working set-based interface for code understanding and maintenance]

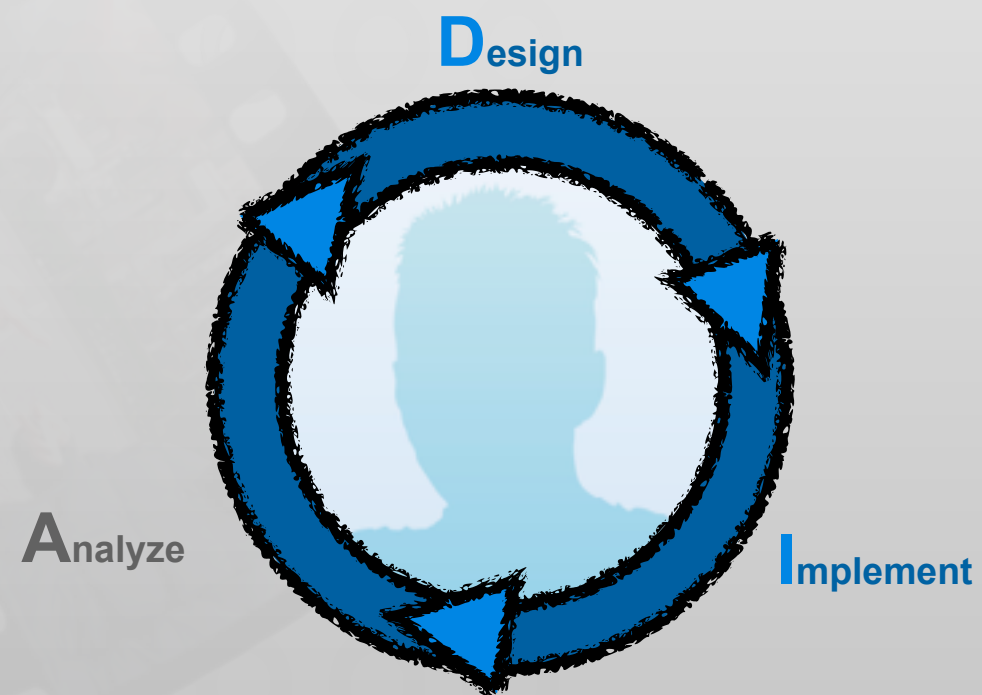


# Canvas Interfaces in the Wild

[DeLine2012, Debugger Canvas: Industrial experience with the code bubbles paradigm]



# Utilizing the Call Graph



# Reachability Questions

[LaToza2010, Developers ask reachability questions]

Where is method m generating an error?	Find output of error text downstream from m
What resources are being acquired to cause this deadlock?	Find calls to methods acquiring the resources
What is this test doing which is different from what my app is doing?	Find differences between two call stacks
Is there another reason why this status is non-zero?	Find upstream statements that change the status





```

- (void)movePapers:(NSArray *)paperInfos forField:(NSString *)field fromDocument:
(BibDocument *)doc options:(NSInteger)mask{
    NSFileManager *fm = [NSFileManager defaultManager];
    NSInteger numberOfPapers = [paperInfos count];
    BibItem *pub = nil;
    BDSKLinkedFile *file = nil;
    NSString *oldPath = nil;
    NSString *newPath = nil;
    NSMutableArray *files = [NSMutableArray arrayWithCapacity:numberOfPapers];
    NSMutableArray *errors = [NSMutableArray arrayWithCapacity:5];
    NSMutableDictionary *info = [NSMutableDictionary];
    NSError *error = nil;

    BOOL initial = (mask & BDSKFileOptionMask);
    BOOL force = (mask & BDSKFileForceOptionMask);
    BOOL check = (initial == YES) && (mask & BDSKCheckCompleteAutoFile);

    if (numberOfPapers == 0)
        return;

    if (initial && [field isEqualToString:BDSKLocalFileString] == NO)
        [NSException raise:BDSKUnimplementedException format:@"%s is only implemented for local files for initial moves.",NSStringFromSelector([cmd])];

    if (numberOfPapers > 1) {
        [self window];
        [progressIndicator setMaxValue:numberOfPapers];
        [progressIndicator setDoubleValue:0.0];
        [[self window] orderFront:nil];
    }

    for (id paperInfo in paperInfos) {
        file = [paperInfo valueForKey:BDSKFileFileKey];
        pub = [paperInfo valueForKey:BDSKFilePublicationKey];
        oldPath = [[file URL] path];
        if (initial) // [BDSKLinkedFile] array of BDSKLinkedFiles
            newPath = [file URLForLinkedFile:file];
        else // an error from one of the info dictionaries
            newPath = [paperInfo valueForKey:BDSKFileNewPathKey];

        if (numberOfPapers > 1) {
            [progressIndicator setDoubleValue:1.0];
            [progressIndicator setDoubleValue:0.0];
        }

        if ([NSString isEqualToString:oldPath] || [NSString isEmptyString:newPath] ||
            [oldPath isEqualToString:newPath]) {
            [pub removeFileToBeFiled:file];
            continue;
        }

        info = [NSMutableDictionary dictionaryWithCapacity:6];
        [info setValue:file forKey:BDSKFileFileKey];
        [info setValue:oldPath forKey:BDSKFileOldPathKey];
        [info setValue:pub forKey:BDSKFilePublicationKey];
        error = nil;

        if (check && NO == [pub canSetURLForLinkedFile:file]) {
            [info setValue:NSLocalizedString(@"Incomplete information to generate file
name.", @"") forKey:BDSKFileStatusKey];
            [info setValue:[NSNumber numberWithInt:BDSKIncompleteFieldsErrorMask]
forKey:BDSKFileFlagKey];
            [info setValue:NSLocalizedString(@"Move anyway.", @"") forKey:BDSKFileFixKey];
            [info setValue:newPath forKey:BDSKFileNewPathKey];
        }
    }
}

```

```

- (NSURL *)suggestedURLForLinkedFile:(BDSKLinkedFile *)file
{
    NSString *papersFolderPath = [BDSKFormatParser folderPathForFilingPapersFromDocumentAtP
    NSString *relativeFile = [BDSKFormatParser parseFormatForLinkedFile:file ofItem:self];
    if ([NSUserDefaults standardUserDefaults] objectForKey:BDSKLocalFileFormat) {
        relativeFile = [relativeFile lowercaseString];
        return [NSURL fileURLWithPath:[papersFolderPath stringByAppendingPathComponent:relativeFile]];
    }
}

+ (NSString *)parseFormatForLinkedFile:(BDSKLinkedFile *)file ofItem:(id <BDSKParseableItem
{
    NSString *localFileFormat = [[NSUserDefaults standardUserDefaults] objectForKey:BDSKLoc
    [self parseFormat:localFileFormat forLinkedFile:file ofItem:pub];
}

+ (NSString *)parseFormat:(NSString *)format forLinkedFile:(BDSKLinkedFile *)file ofItem:(id
{
    NSString *papersFolderPath = [self folderPathForFilingPapersFromDocumentAtPath:[pub o
    NSString *relativeFile = [BDSKFormatParser parseFormatForLinkedFile:file ofItem:pub
    if ([relativeFile isEqualToString:BDSKLocalFileString]) {
        [relativeFile lowercaseString];
        return [papersFolderPath stringByAppendingPathComponent:relativeFile];
    }
    return [papersFolderPath stringByAppendingPathComponent:[relativeFile lowercaseString]];
}

+ (NSString *)parseFormat:(NSString *)format forField:(NSString *)field ofItem:(id <BDSKParseableItem
{
    NSMutableString *parsedStr = [NSMutableString string];
    [parsedStr appendString:@"TRIAL"];
    NSString *prefixStr = nil;
    NSScanner *scanner = [NSScanner scannerWithString:format];
    NSUInteger uniqueNumber;
    unichar specifier, nextChar, uniqueSpecifier = 0;
    NSString *uniqueSeparator = nil;
    NSString *slashCharSet = [NSString stringWithFormat:@"%s", [BDSKCharacterSet charactersInString:@" /"]];
    BOOL isLocalFile = [field isEqualToString:BDSKLocalFileString];

    [scanner setCharactersToBeSkipped:nil];

    while (NO == [scanner isAtEnd]) {
        if ([scanner scanString:@"%" intoString:&specifier]) {
            if ([specifier isEqualToString:@"a"]) {
                // author names, optional [separator], [etal], #names and #chars
                NSUInteger numChars = 0;
                NSUInteger i, numAuth = 0;
                NSString *authSep = @" ";
                NSString *etal = @" et al";
                BOOL isLast = NO;
                if (NO == [scanner isAtEnd]) {

```

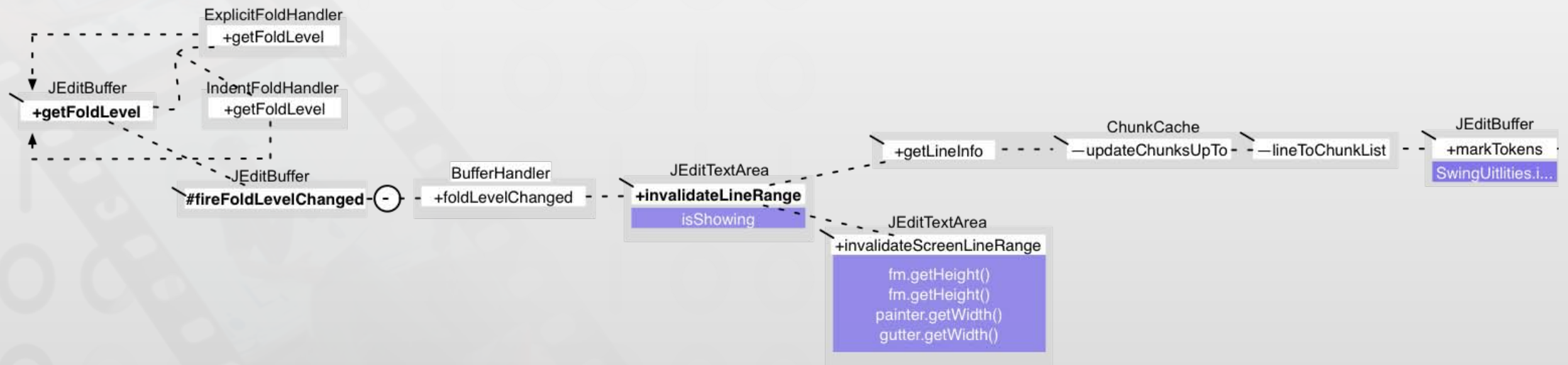
# In practice: Feasible paths most interesting

[LaToza2010, Developers ask reachability questions]



# Utilizing Call Graph Information

[LaToza2010, Searching Across Paths]



## Legend

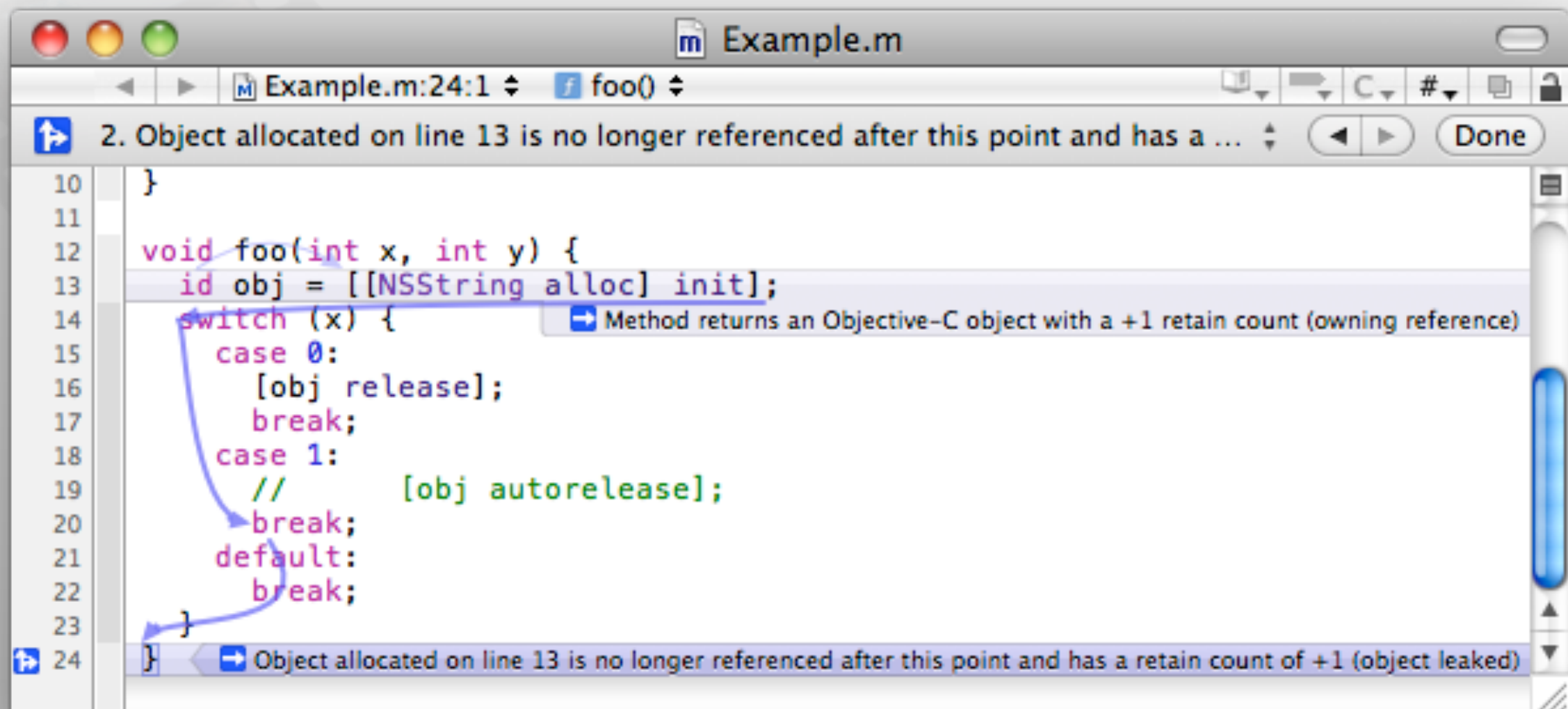
<code>+methodName</code>	public / protected / private method	————	method call that is always executed		recursive method call
<code>#methodName</code>	method visited by developer	- - - -	method call that might execute	- - - -	paths of calls with hidden methods
<code>-methodName</code>	method with callers that are not shown	- - - -	mutually exclusive method calls	→	data flow
<code>TypeName</code>	type with type name	- - - -	method call in a loop	<code>expression</code>	expression that matches search





# Static Analysis in the Wild

[Clang Static Analyzer, <http://clang-analyzer.llvm.org/>]



The screenshot shows a code editor window titled "Example.m". The code is as follows:

```
10 }
11
12 void foo(int x, int y) {
13     id obj = [[NSString alloc] init];
14     switch (x) {
15         case 0:
16             [obj release];
17             break;
18         case 1:
19             // [obj autorelease];
20             break;
21         default:
22             break;
23     }
24 }
```

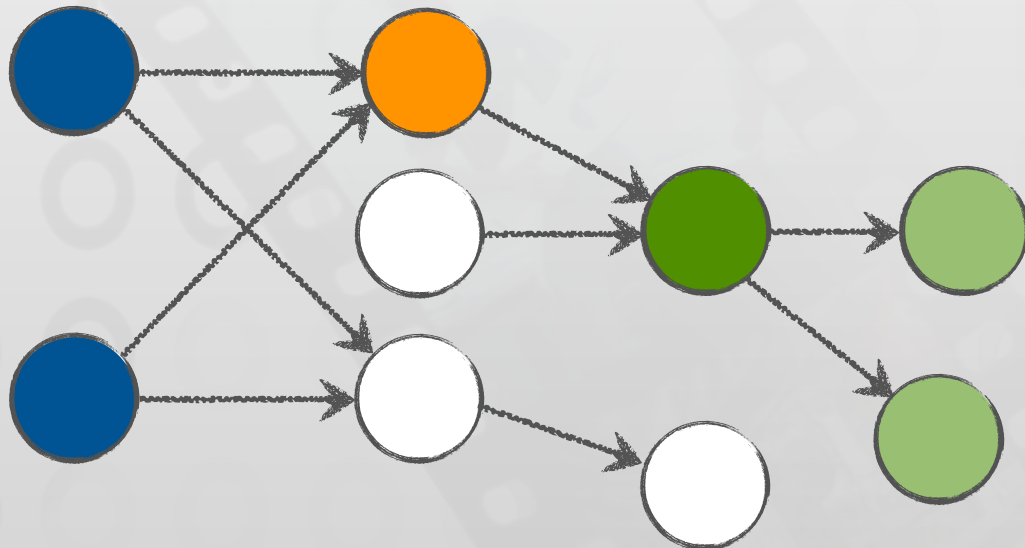
Two Clang Static Analyzer warnings are displayed:

- Warning 2: "Object allocated on line 13 is no longer referenced after this point and has a ..." (partially visible). A blue arrow points from this warning to the line containing `id obj = [[NSString alloc] init];`.
- Warning 1: "Method returns an Objective-C object with a +1 retain count (owning reference)". A blue arrow points from this warning to the line containing `[obj autorelease];`.
- Warning 2: "Object allocated on line 13 is no longer referenced after this point and has a retain count of +1 (object leaked)". A blue arrow points from this warning to the closing brace of the `foo` function at line 24.





# Call Hierarchy



```
Converter.xcodeproj
MainController.m:39:1
- (void)convertClicked:(id)sender;
{
    //do something
    if (self.theConverter == nil) {
        self.theConverter = [[Converter alloc] init];
    }
    [self performConvert];
}

- (void)performConvert;
{
    if ([self.input floatValue] != 0) || ([self.input st
    {
        [self convert];
    }
}

- (void)menuCallback:(id)sender;
{
    [self convert];
}

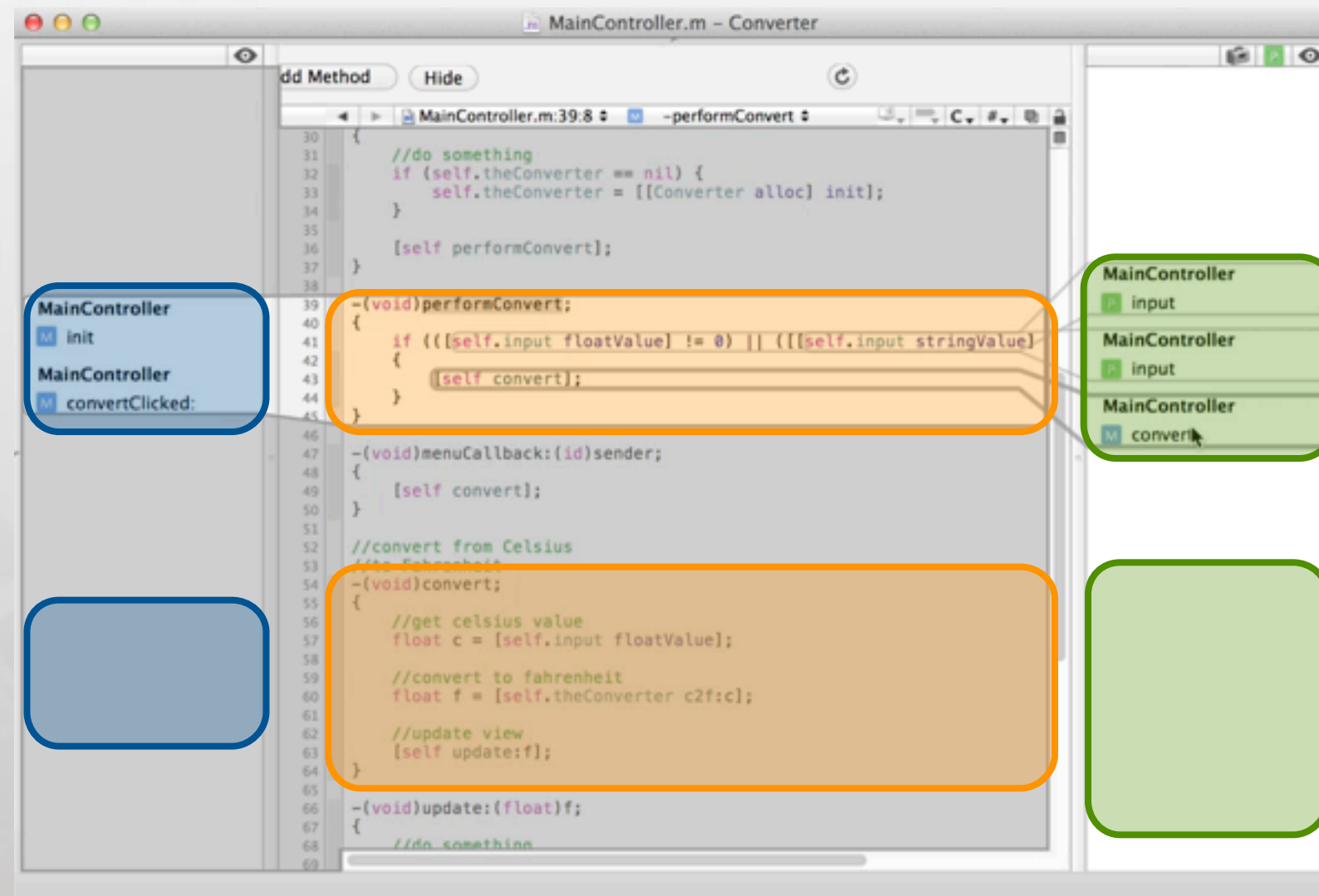
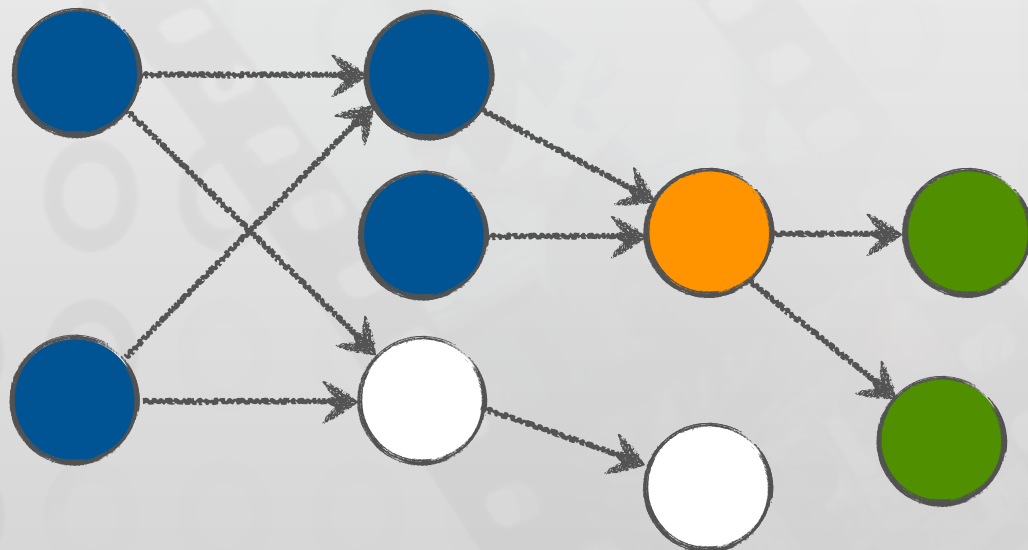
//convert from Celsius
//to Fahrenheit
- (void)convert;
{
    //get celsius value
    float c = [self.input floatValue];
    //convert to fahrenheit
    float f = [self.theConverter c2f:c];
    //update view
    [self update:f];
}

- (void)update:(float)f;
{
    //do something
}

@end
```

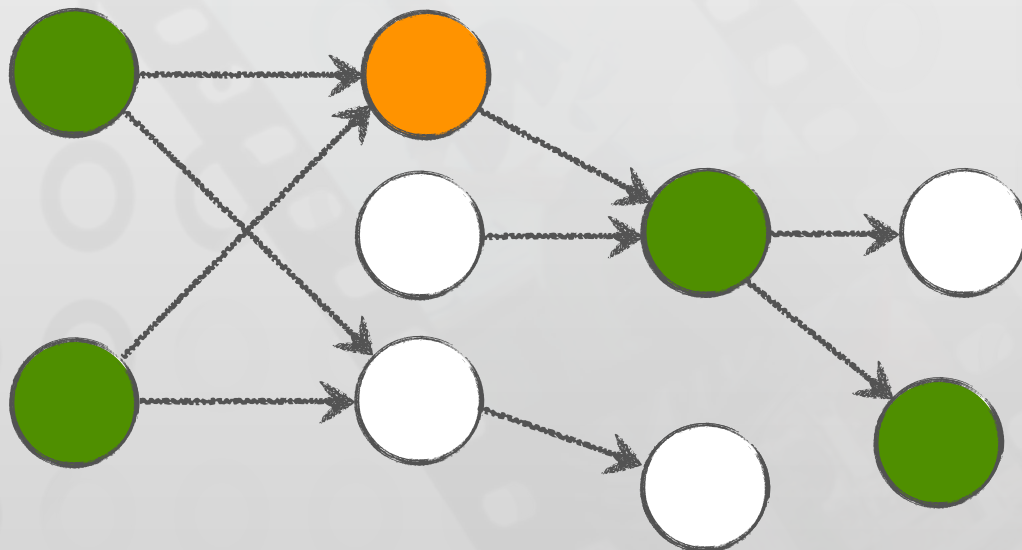
# Stacksplorer

[Karrer2011, Stacksplorer: Call Graph Navigation Helps Increasing Code Maintenance Efficiency]



# Blaze

[Krämer2012, Blaze: Supporting Two-phased Call Graph Navigation in Source Code]

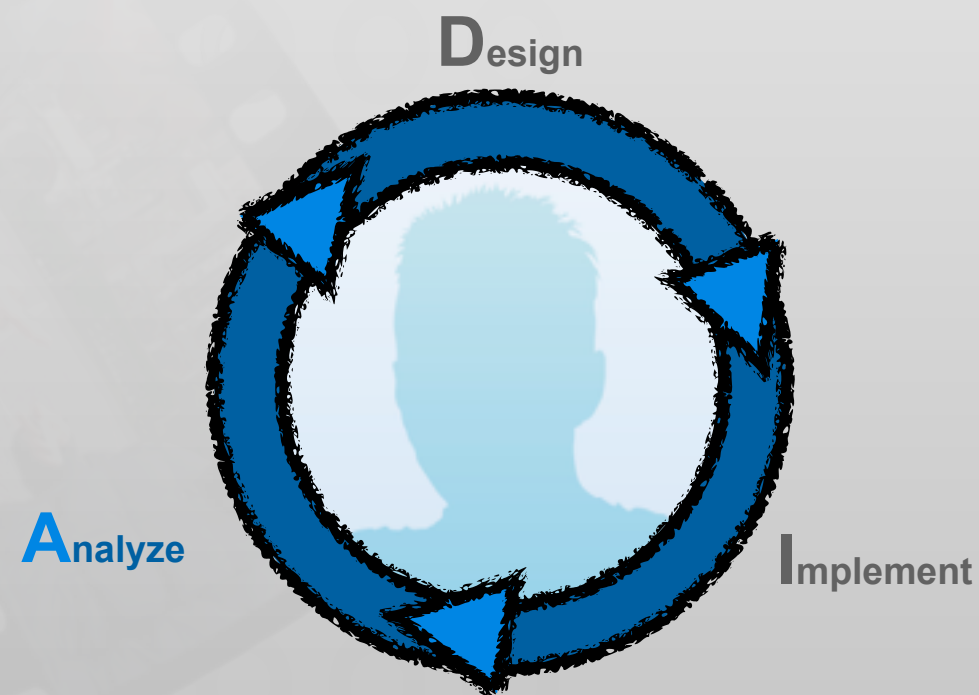


```
24 }
25 return self;
26 }
27
28
29 -(void)convertClicked:(id)sender;
30 {
31     //do something
32     if (self.theConverter == nil) {
33         self.theConverter = [[Converter alloc] init];
34     }
35     [self performConvert];
36 }
37
38
39 -(void)qw;
40 {
41     if ([[self.input floatValue] != 0] || ([[self.input stringValue] isEqual:
42         [self.input stringValue]]) {
43         [self convert];
44     }
45 }
46
47 -(void)menuCallback:(id)sender;
48 {
49     [self convert];
50 }
51
52 //convert from Celsius
53 //to Fahrenheit
54 -(void)convert;
55 {
56     //get celsius value
57     float c = [self.input floatValue];
58
59     //convert to fahrenheit
60     float f = [self.theConverter c2f:c];
61
62     //update view
63     [self update:f];
64 }
65
66
```





# Analyzing Navigation Behavior



# Information Foraging Theory



Predator



Scent



Prey





# Information Foraging Theory

[Lawrance2010, Reactive information foraging for evolving goals]



Predator



Scent

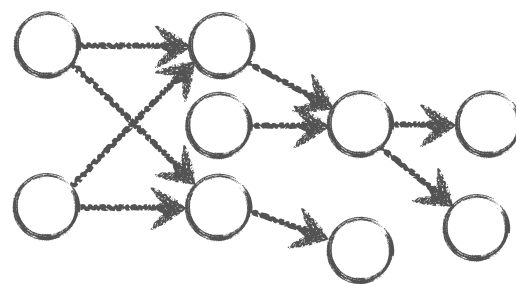


Prey



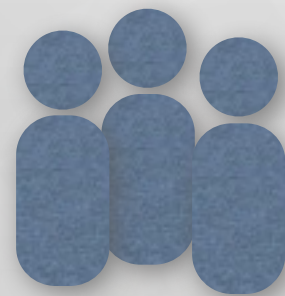
```
- (id)initWithBundle:(NSBundle *)plugin
{
    if (self = [super init]) {
        // reference to plugin's bundle, for resource access
        self.bundle = plugin;

        //register to notifications
        [[NSNotificationCenter defaultCenter] addObserver:self
        selector:@selector(onDidFinishSetup:) name:
        IDESourceCodeEditorDidFinishSetupNotification object:nil];
        [[NSNotificationCenter defaultCenter] addObserver:self
        selector:@selector(onTest:) name:
        DVTSourcesExpressionSelectedExpressionDidChangeNotification
        object:nil];
    }
}
```





	Xcode	Call Hierarchy	Stacksplorer	Blaze
Find Change Location	Task Success Task Completion Time			
Side Effects of Change				



33 Developers



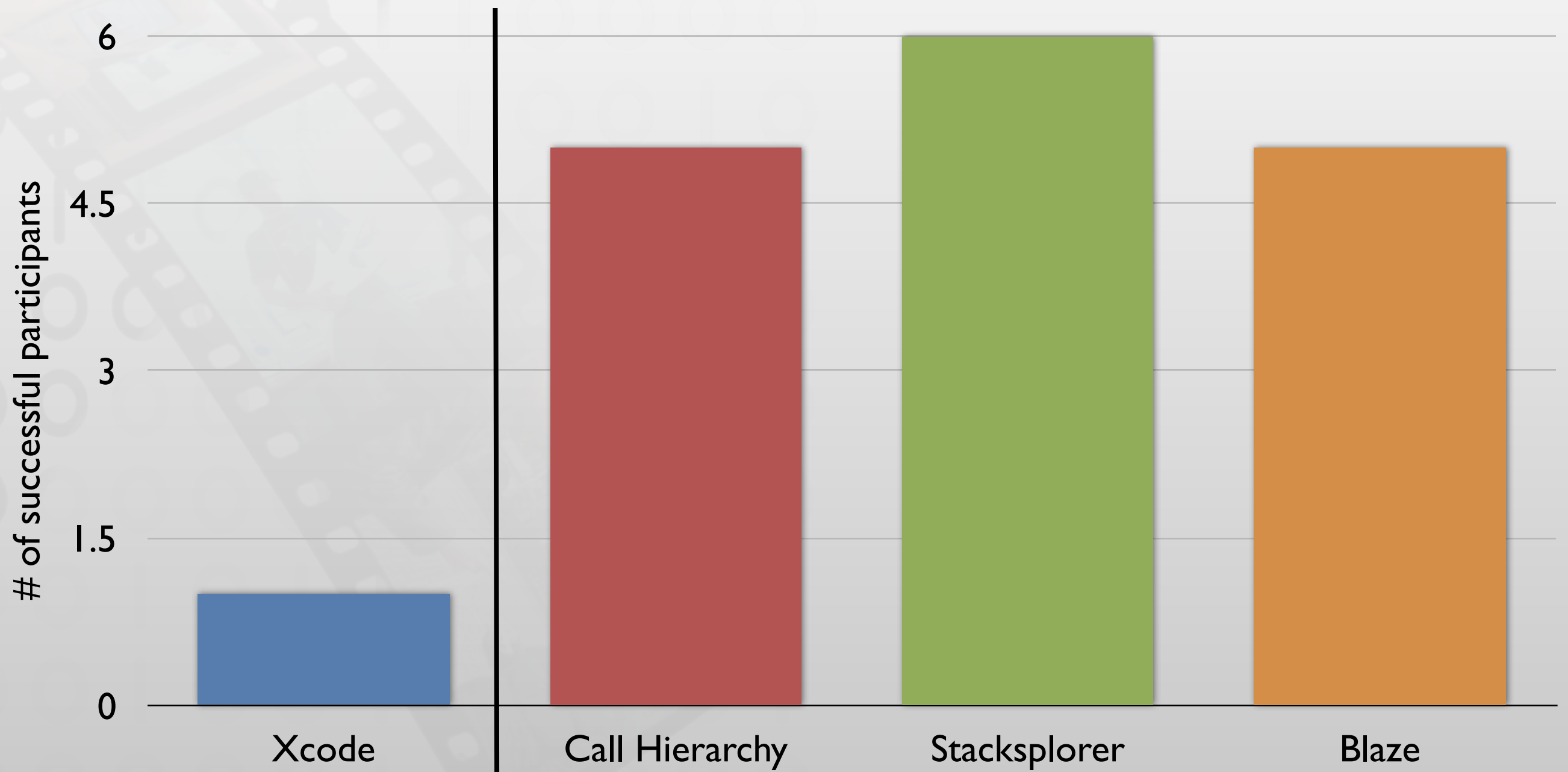
80.000 Lines of Code

[Krämer2013, How Tools in IDEs Shape Developers' Navigation Behavior]



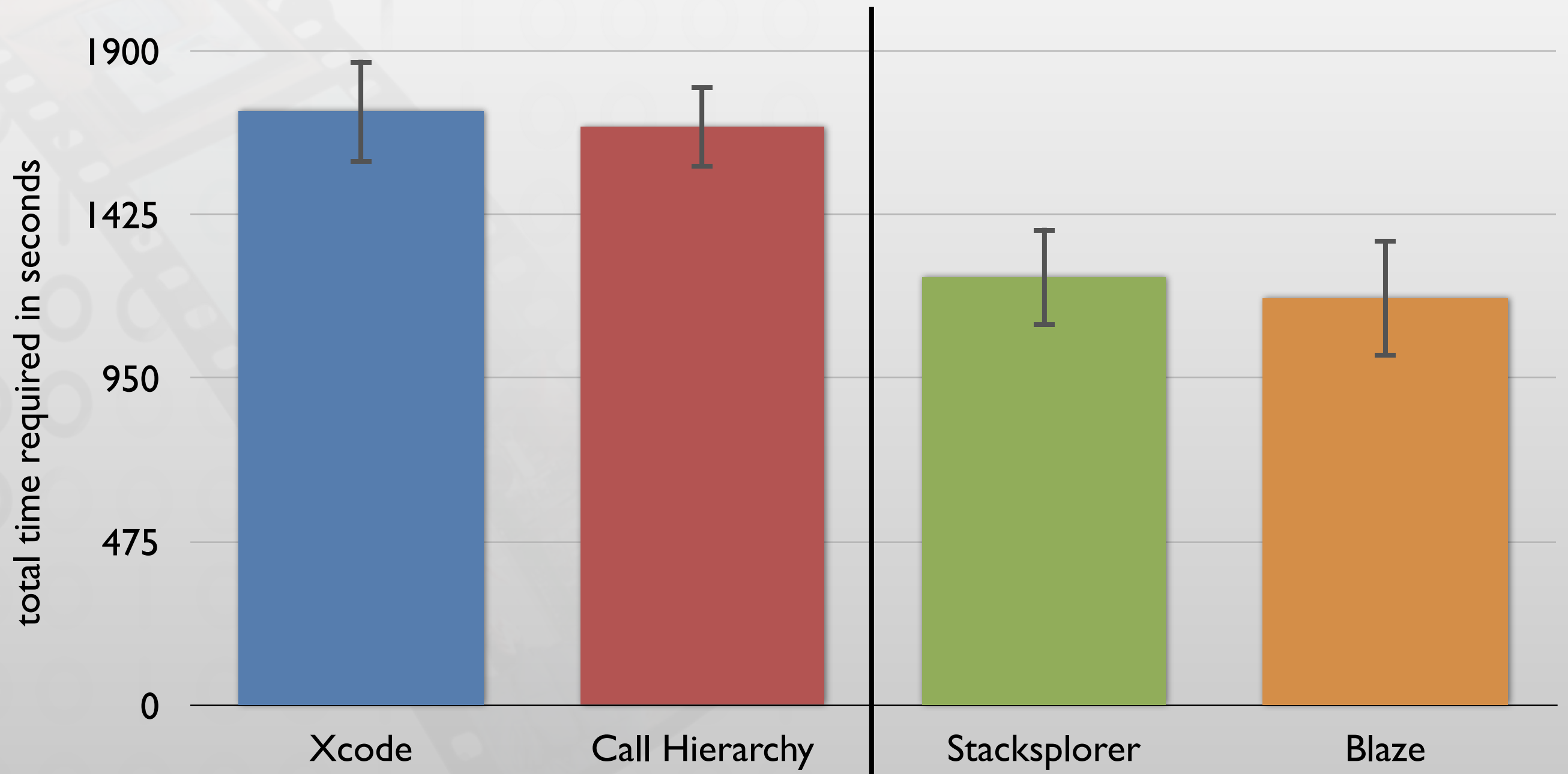
# Task Success

$p = 0.015$



# Task Completion Time

$p=0.022$





Effectiveness

Xcode

Call  
Hierarchy

Stacksplorer

Blaze

Efficiency

Xcode

Call  
Hierarchy

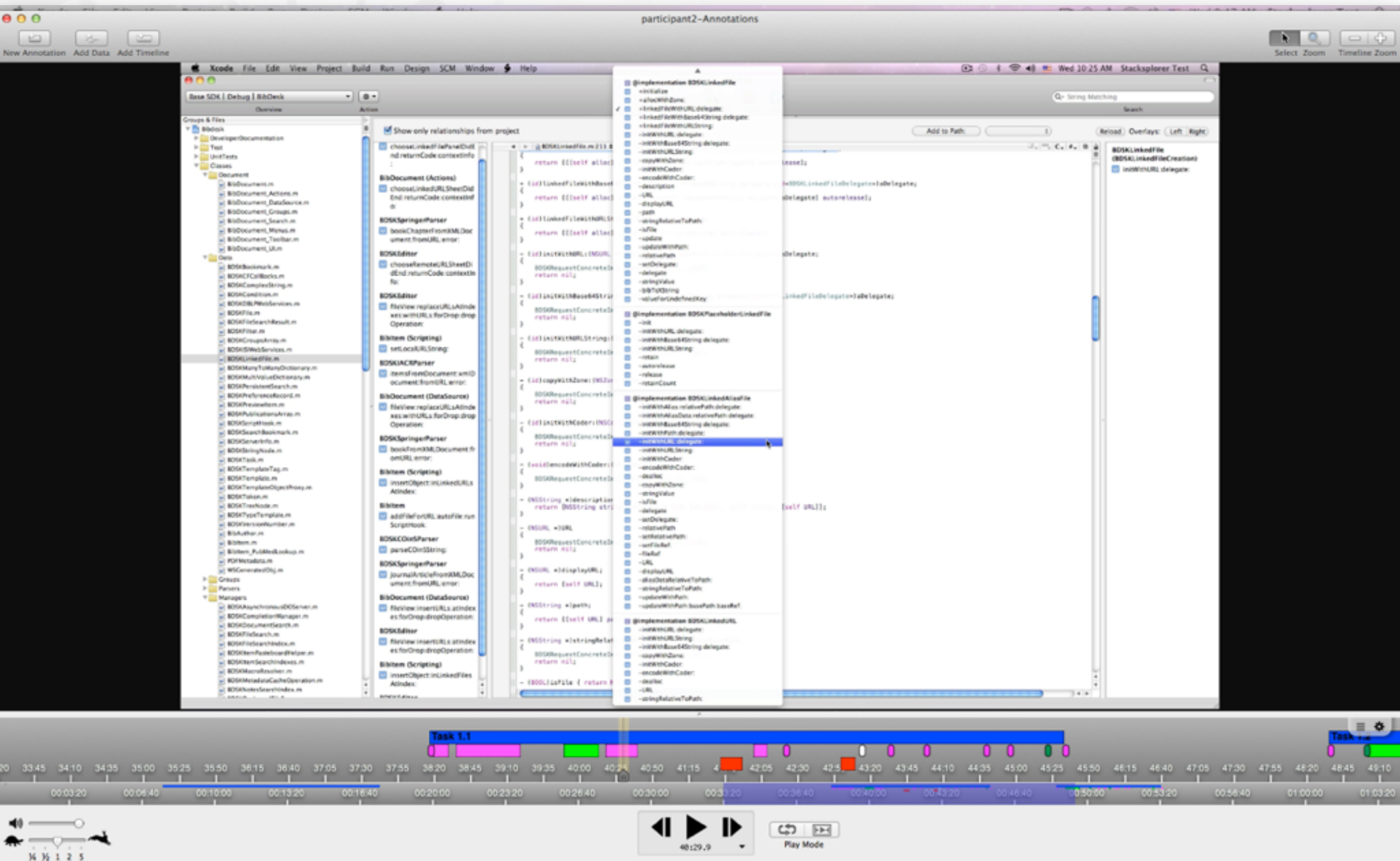
Stacksplorer

Blaze

Why?

UI Differences

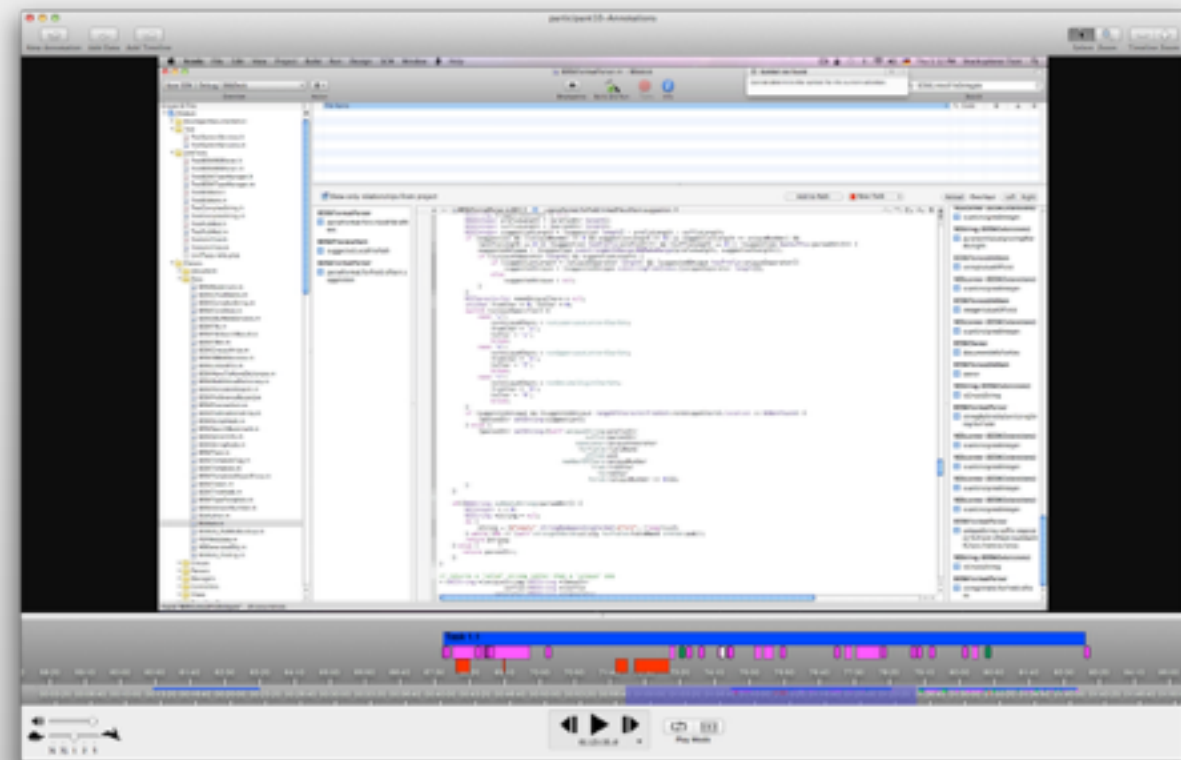
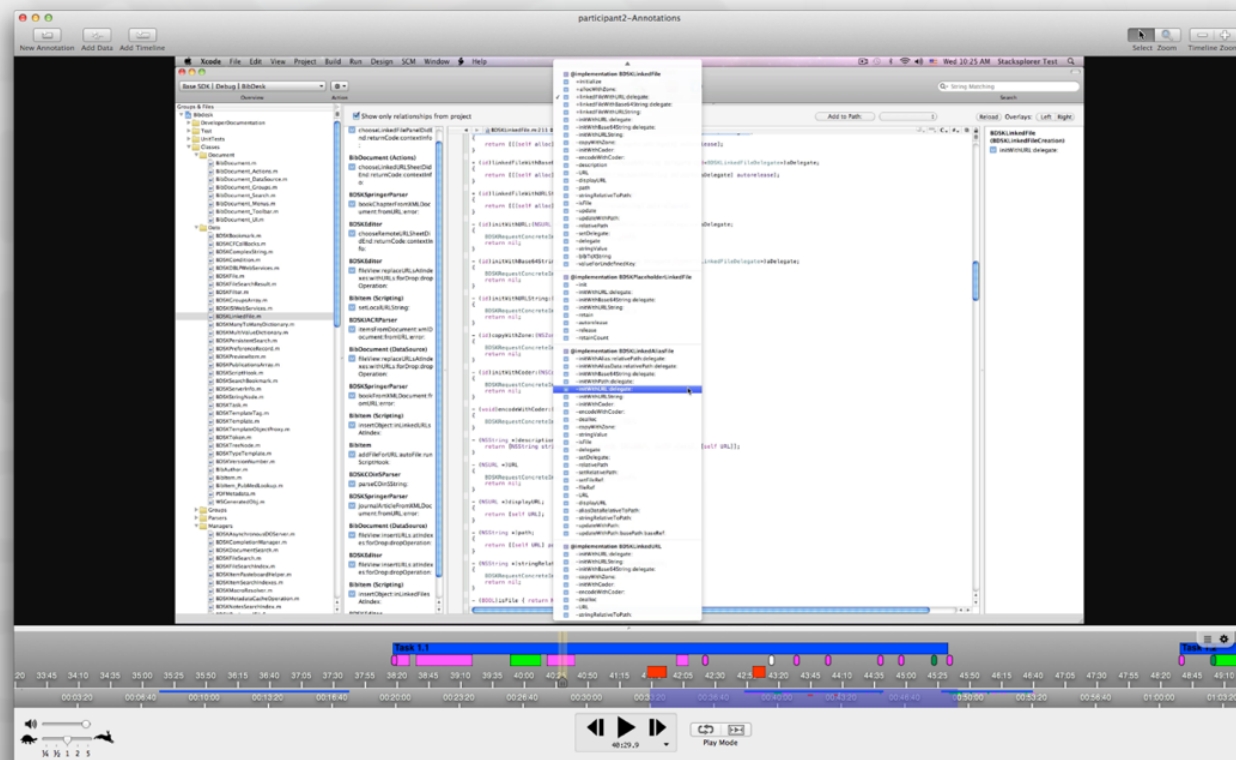
Navigation Behavior



[Fouse2011, ChronoViz: A system for supporting navigation of time-coded data]



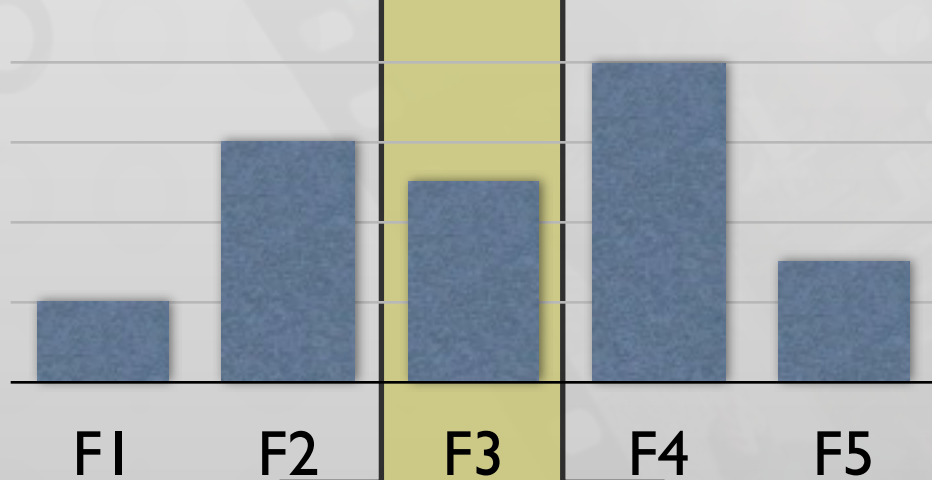
# Comparing Navigation Behavior



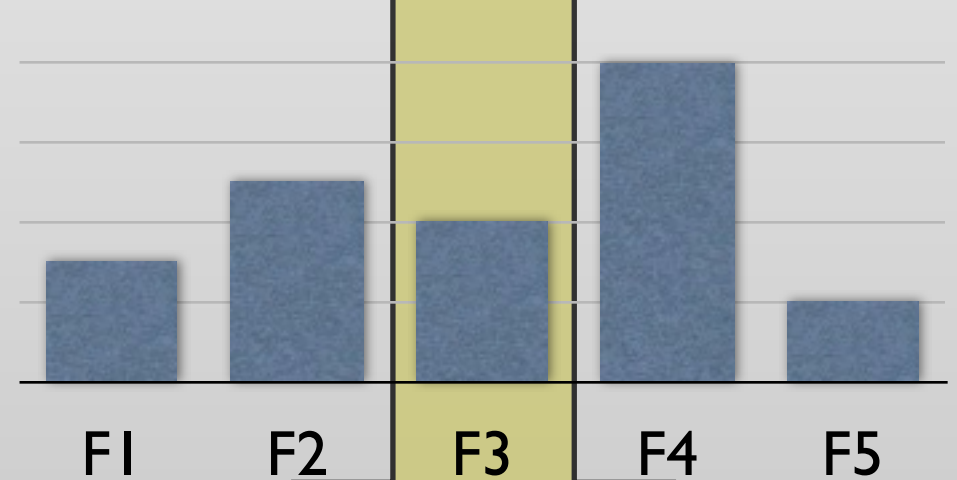




$$I_1 = (p_{1,1}, \dots, p_{640,480})$$



$$I_2 = (p_{1,1}, \dots, p_{1024,768})$$

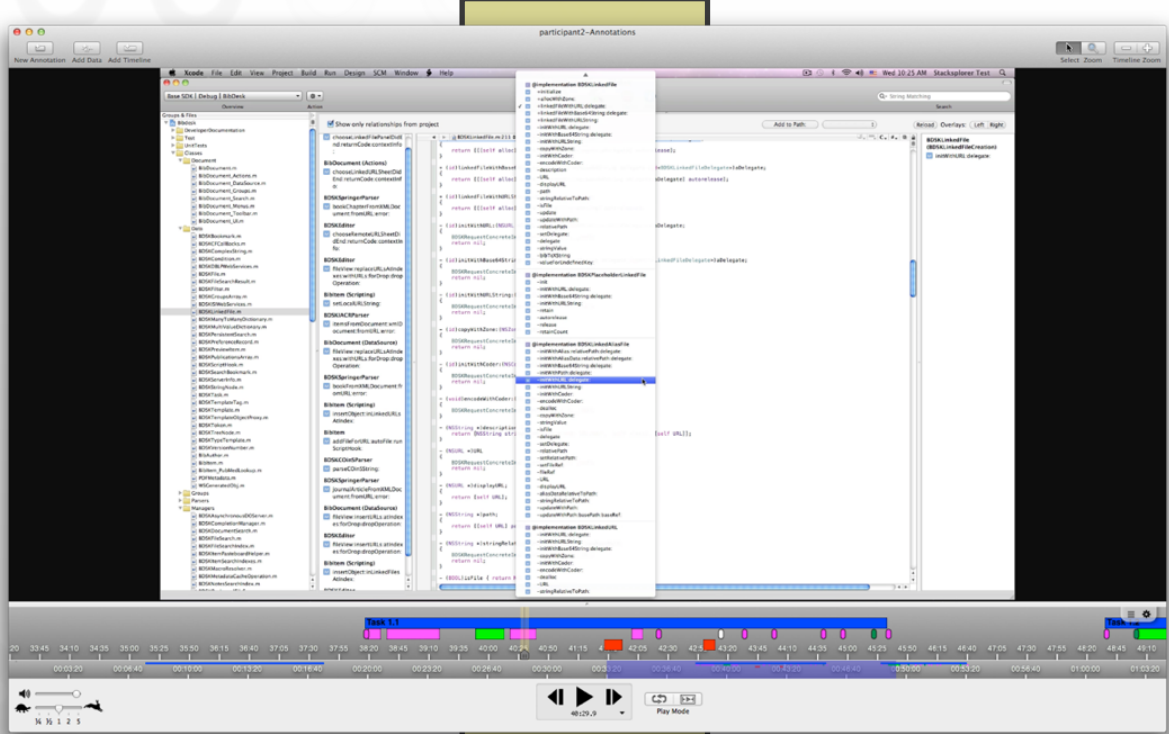


# I. Features

## 2. Transformations

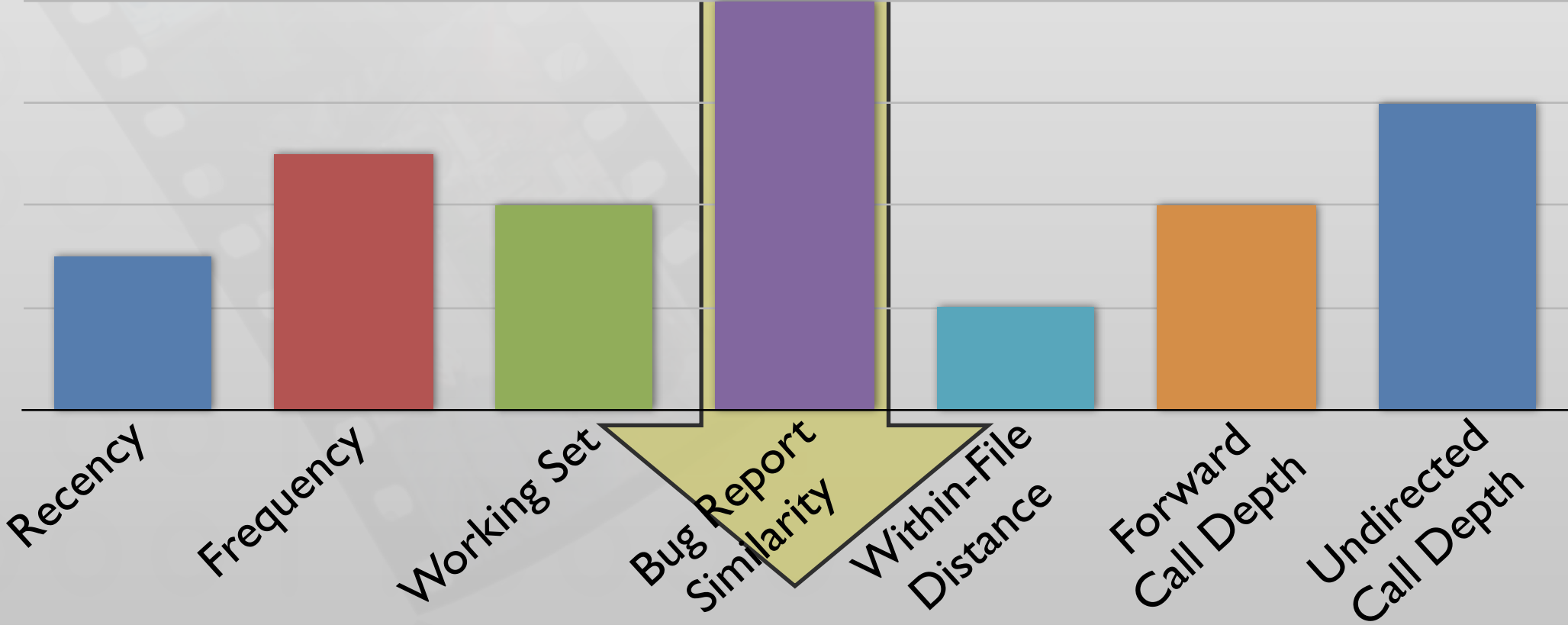


[Piorkowski2011,  
Modeling programmer  
navigation:A head-to-  
head empirical evaluation  
of predictive models]



$$H=(m_1, \dots, m_i)$$

Prediction Accuracy



# A Predictor

[Piorkowski2011, Modeling programmer navigation: A head-to-head empirical evaluation of predictive models]

$$H = (m_1, \dots, m_i)$$

Navigation History

$$H = (a, b, a, d)$$

$$M_i$$

All methods known  
to developer at time  
 $i$

$$M_4 = \{a, b, d\}$$

$$A_i: M_i - \{m_i\} \rightarrow \mathbb{R}$$

Activation value for  
each method in  $M_i$

$$A_4(a) = 3$$

$$A_4(b) = 2$$

$$R_i: M_i - \{m_i\} \rightarrow \mathbb{N}$$

Rank-transformed  
version of  $A_i$

$$R_4(a) = 1$$

$$R_4(b) = 2$$

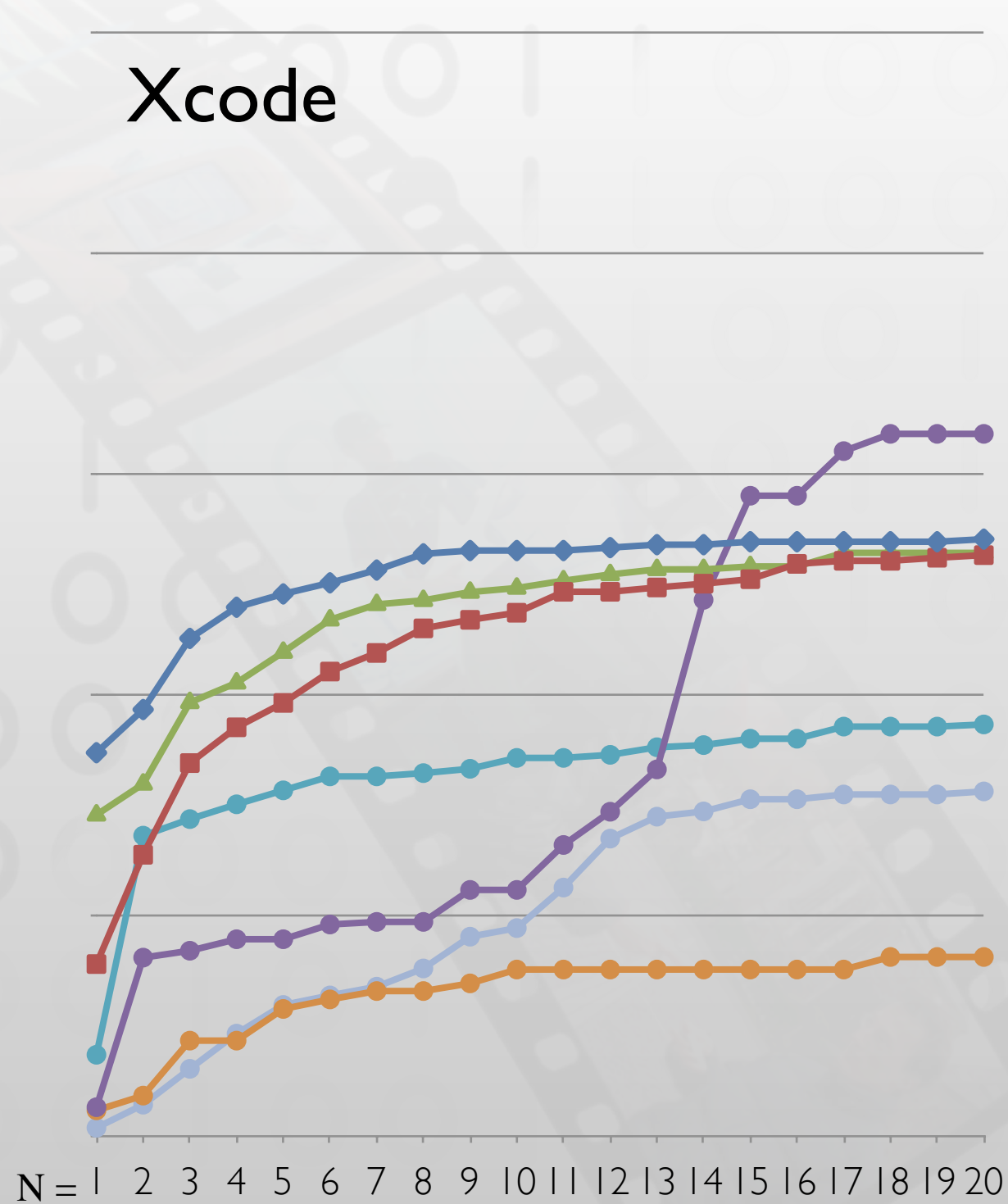
Result:  $N$  top-ranked methods



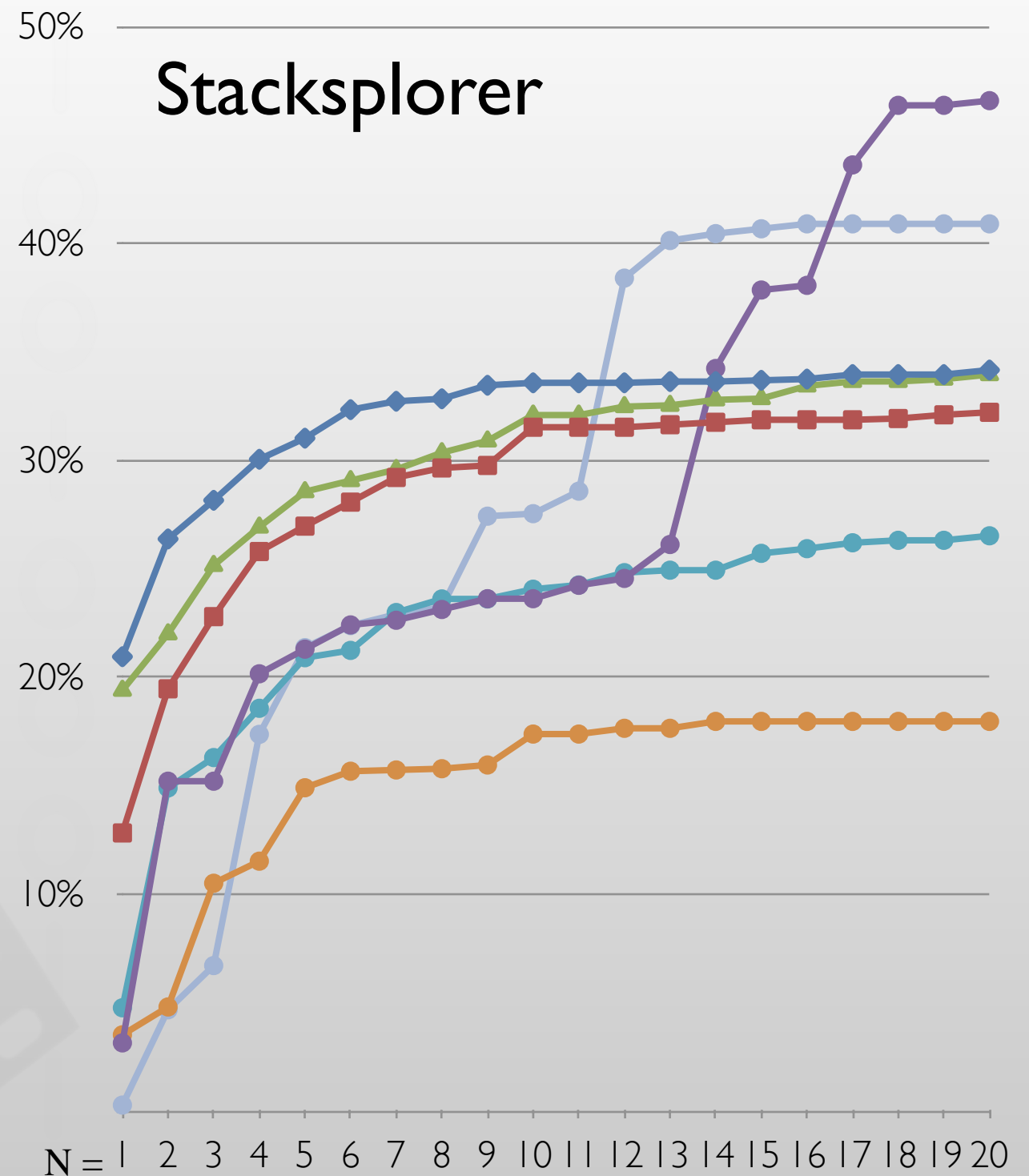


# Prediction Accuracy

## Xcode



## Stacksplorer

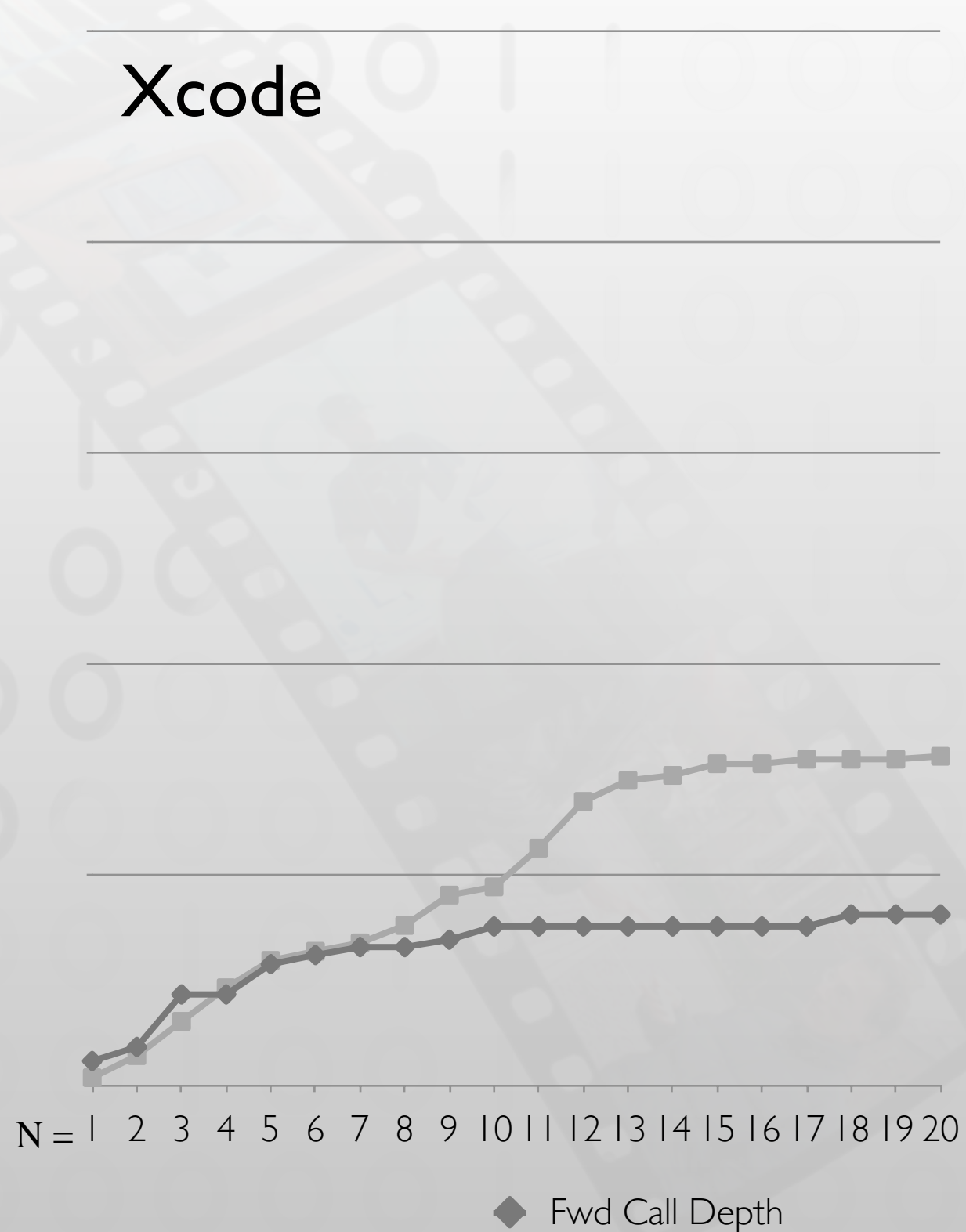


- Recency
- Frequency
- Working Set
- Bug Report Similarity
- Within File Distance
- Fwd Call Depth
- Undirected Call Depth

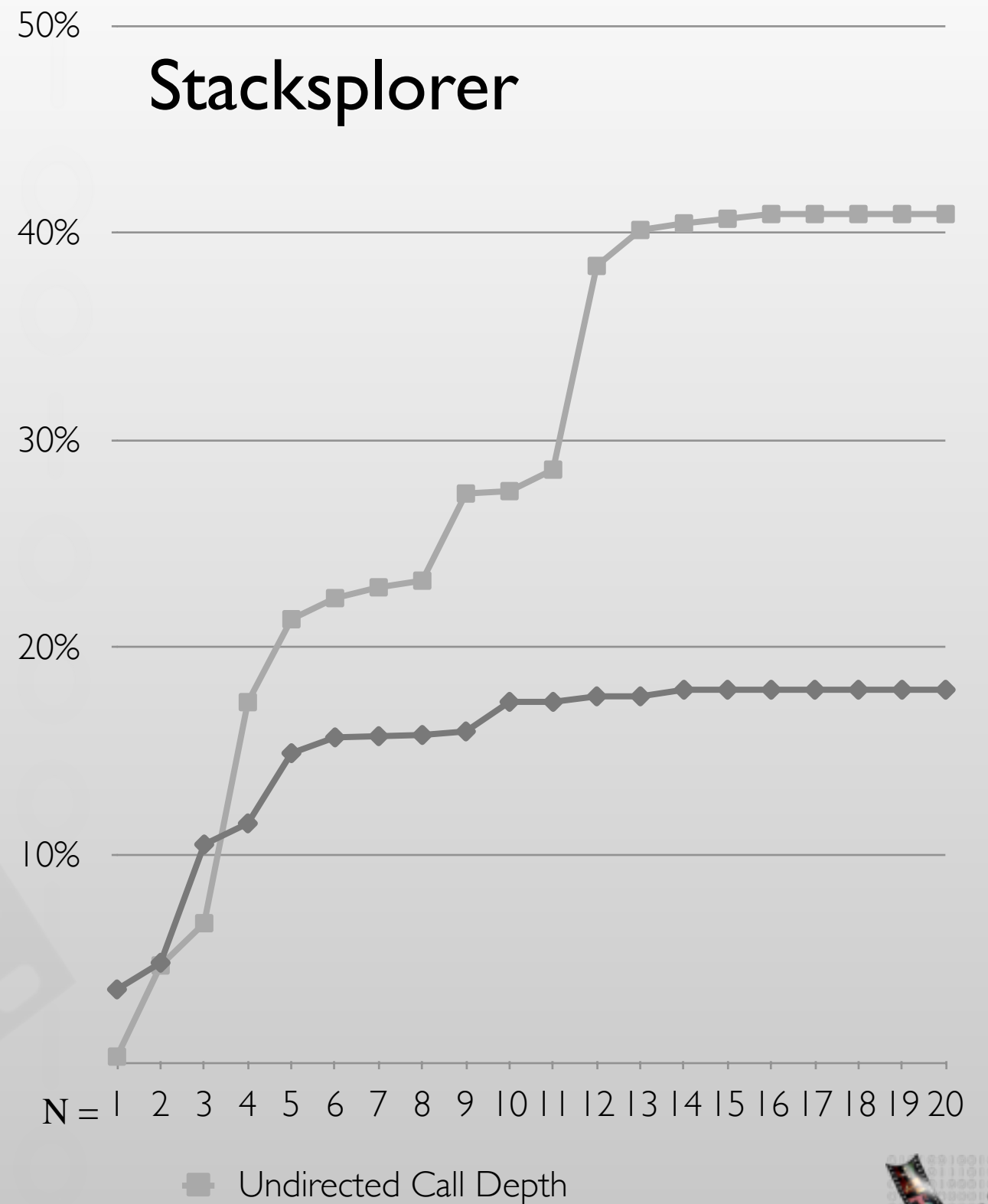


# Prediction Accuracy

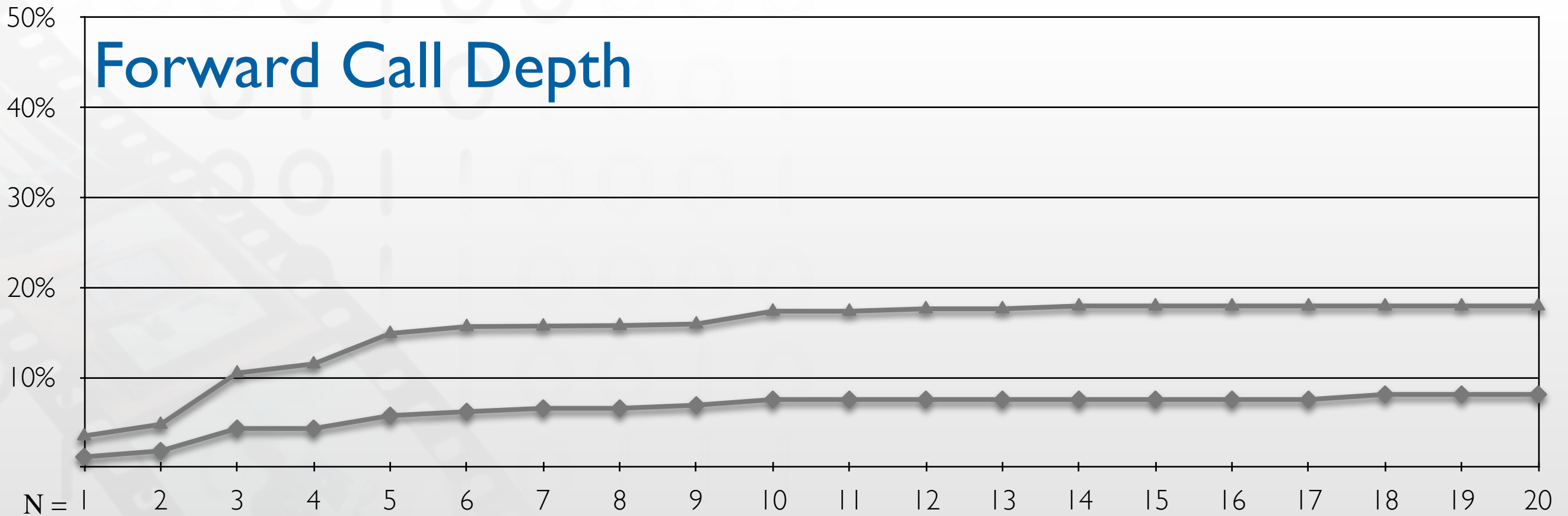
## Xcode



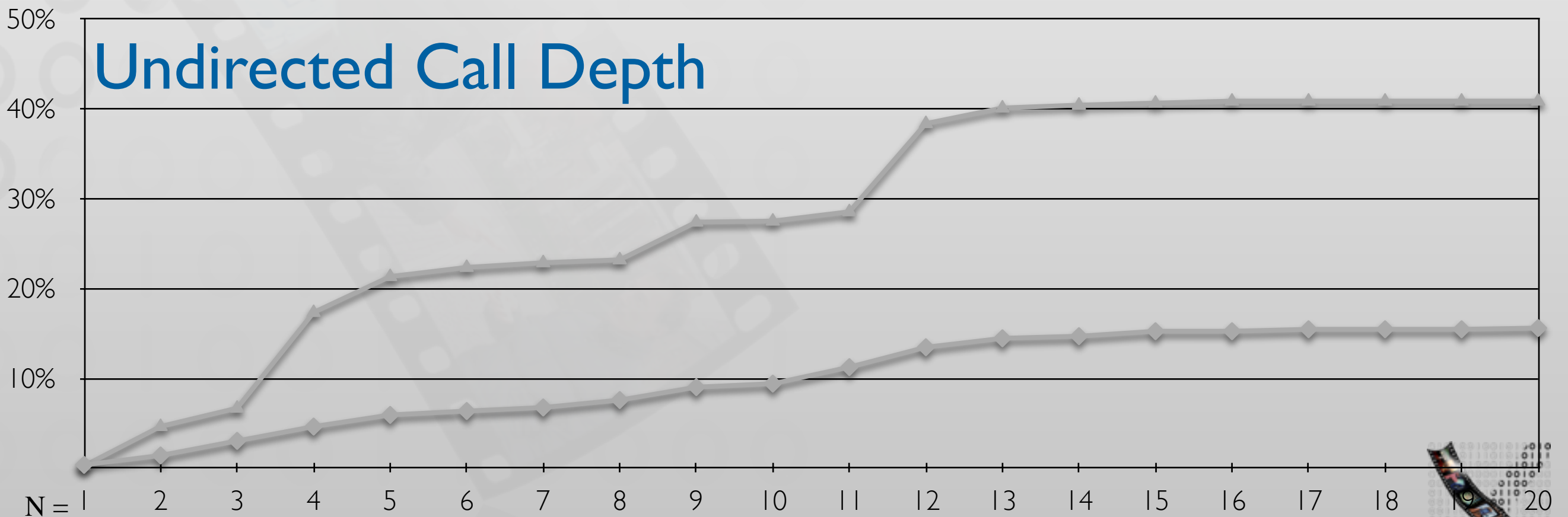
## Stacksplorer



# Forward Call Depth

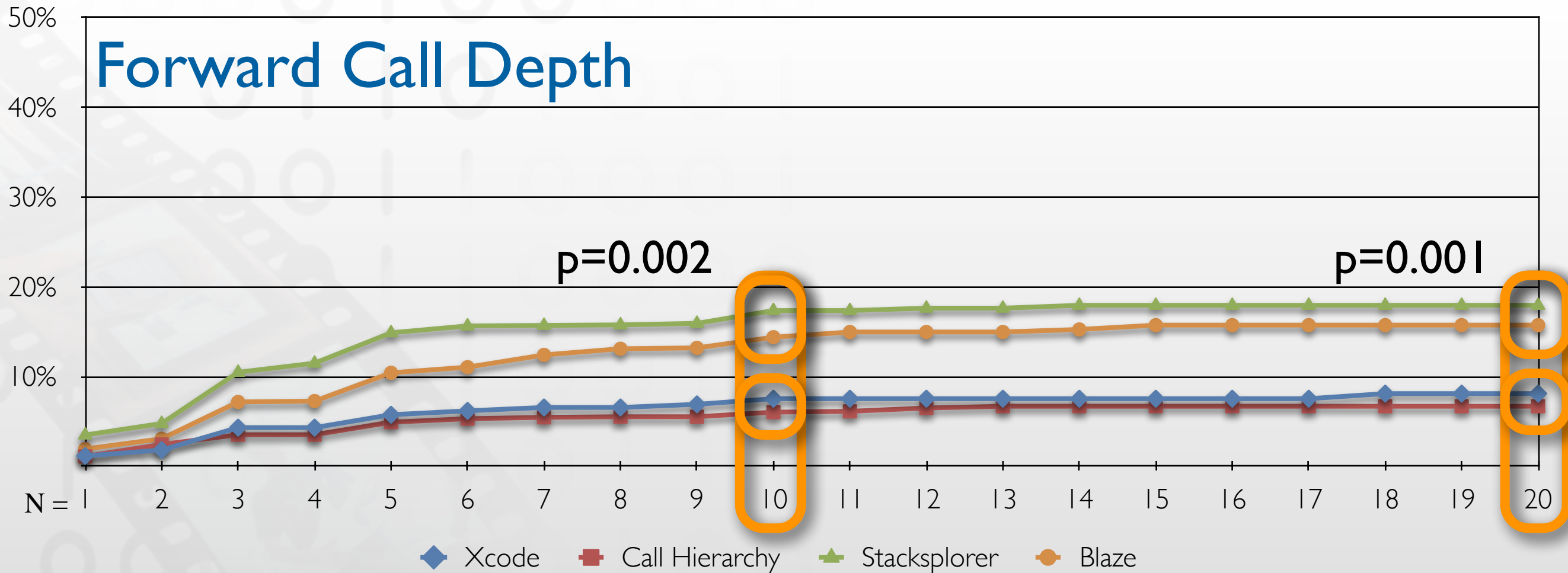


# Undirected Call Depth

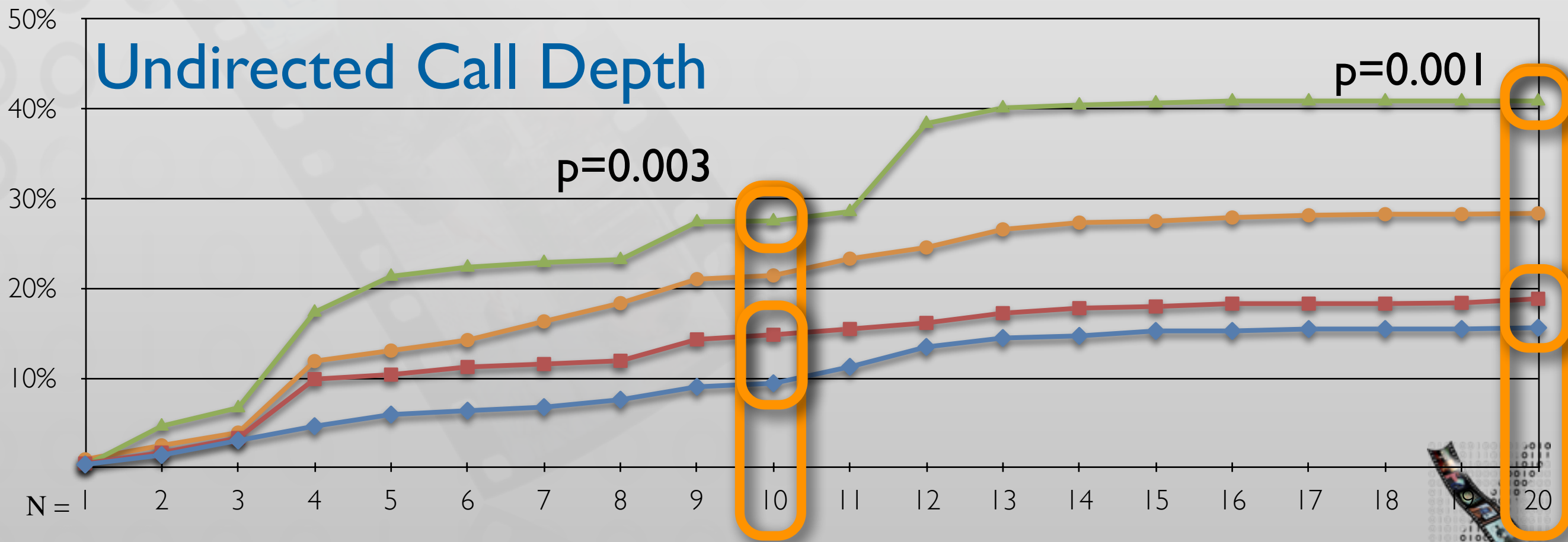




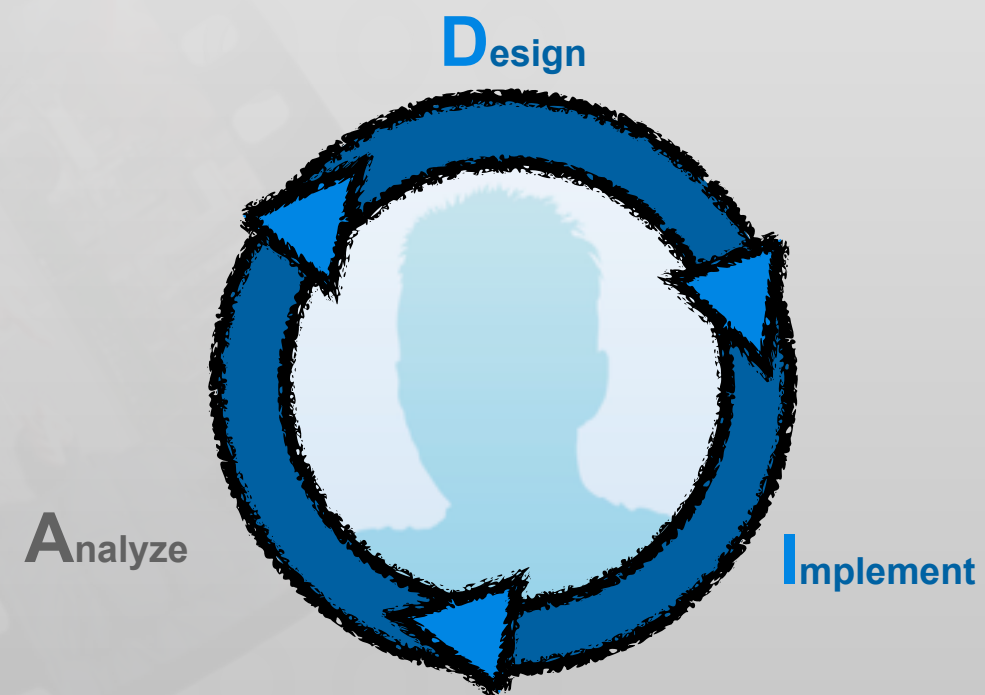
# Forward Call Depth



# Undirected Call Depth

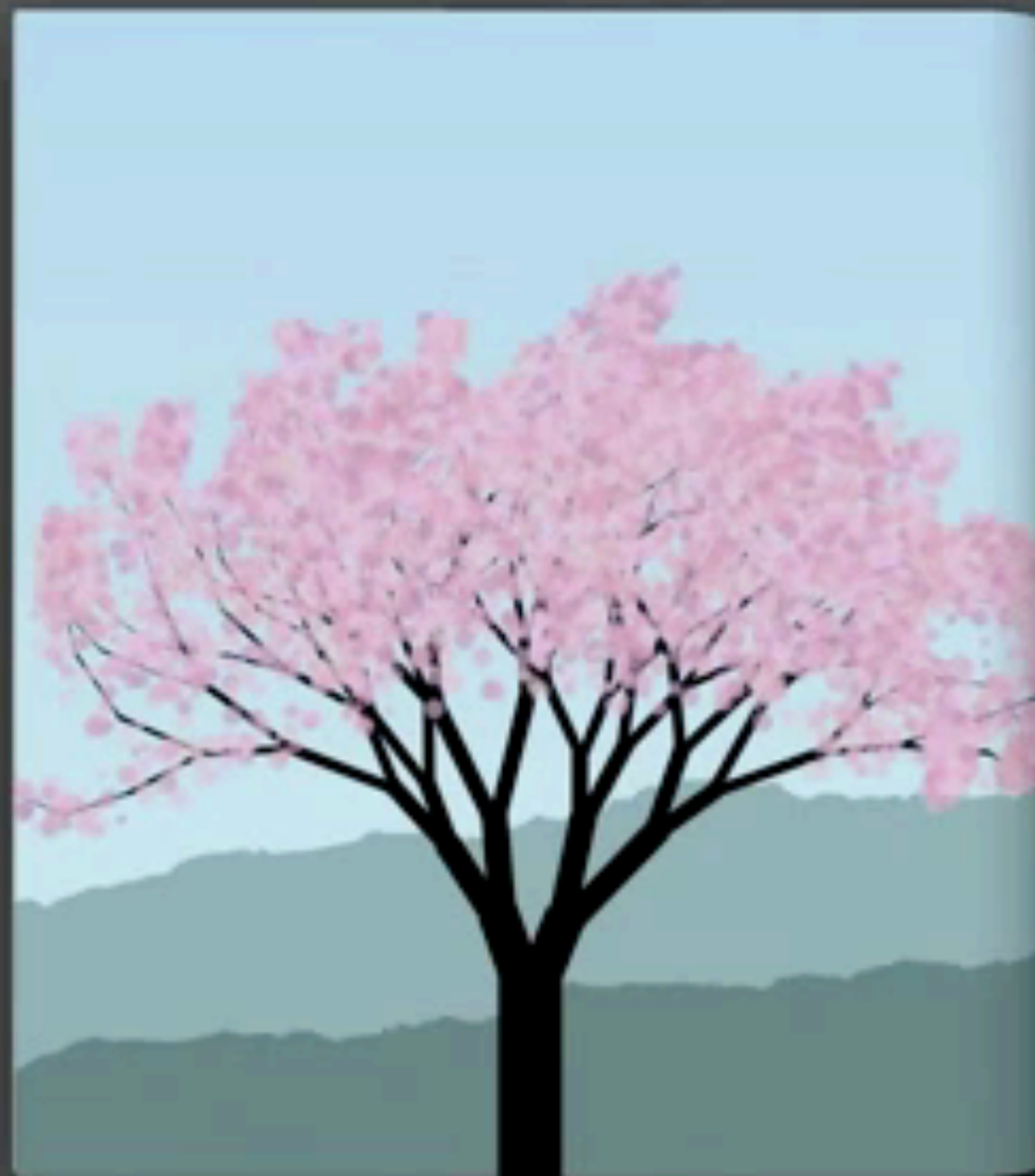


# Away from static analysis only



*// Introducing Codelets...*





```
// tree
//
function drawTree () {
  var blossomPoints = [];

  resetRandom();
  drawBranches(0, -Math.PI/2, canvasWidth/2, canvasHeight, 30,
  resetRandom();
  drawBlossoms(blossomPoints);
}

function drawBranches (i,angle,x,y,width,blossomPoints) {
  ctx.save();

  var length = tween(i, 1, 60, 12, 3) + random(0.7, 1.3);
  if (i == 0) { length = 97; }

  ctx.translate(x,y);
  ctx.rotate(angle);
  ctx.fillStyle = "#800080";
  ctx.fillRect(0, -width/2, length, width);

  ctx.restore();

  var tipX = x + (length - width/2) * Math.cos(angle);
  var tipY = y + (length - width/2) * Math.sin(angle);

  if (i > 4) {
    blossomPoints.push([x,y,tipX,tipY]);
  }

  if (i < 6) {
    drawBranches(i + 1, angle + random(-0.15, -0.05) * Math.PI);
    drawBranches(i + 1, angle + random( 0.15,  0.05) * Math.PI);
  }
  else if (i < 12) {
    drawBranches(i + 1, angle + random(-0.25, -0.05) * Math.PI);
    drawBranches(i + 1, angle + random( 0.25,  0.05) * Math.PI);
  }
}
```

```
1  /*jslint plusplus: true, node: true, white: tru
2
3  var arr = [6, 2, 8, 4, 3];
4
5  var i;
6  for (i = 1; i < arr.length; i++) {
7      var j = i;
8
9      while ((j > 0) && (arr[j-1] > arr[j])) {
10         var tmp = arr[j-1];
11         arr[j-1] = arr[j];
12         arr[j] = tmp;
13
14         j = j-1;
15     }
16 }
17 console.log(arr);
```

[6, 2, 8, 4, 3]

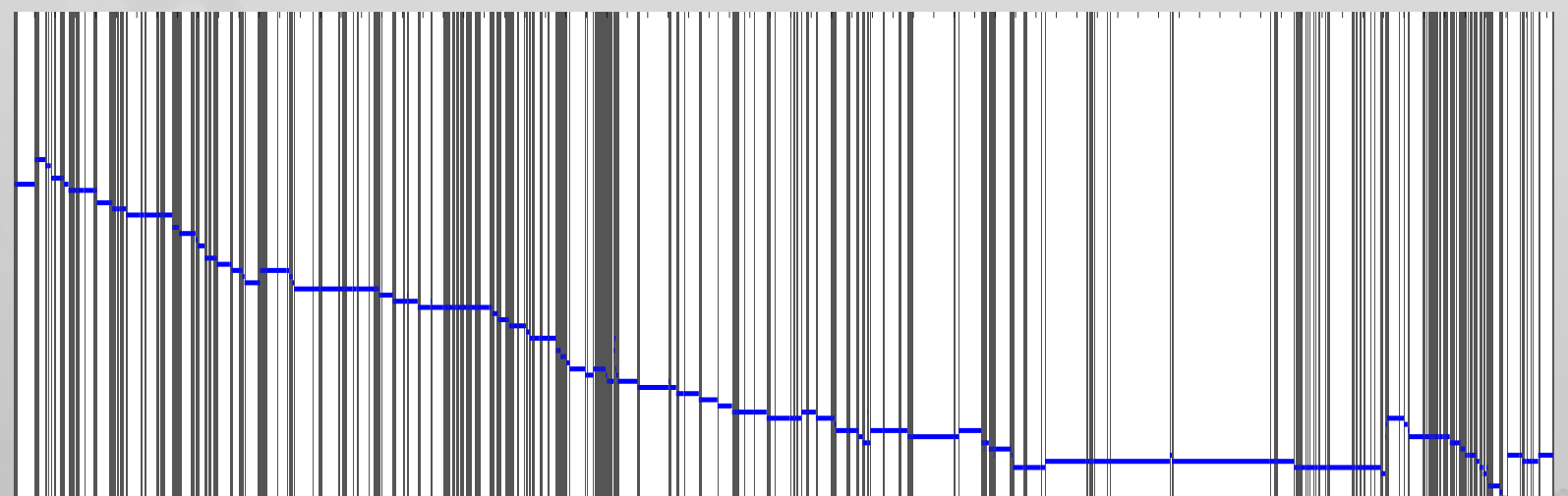
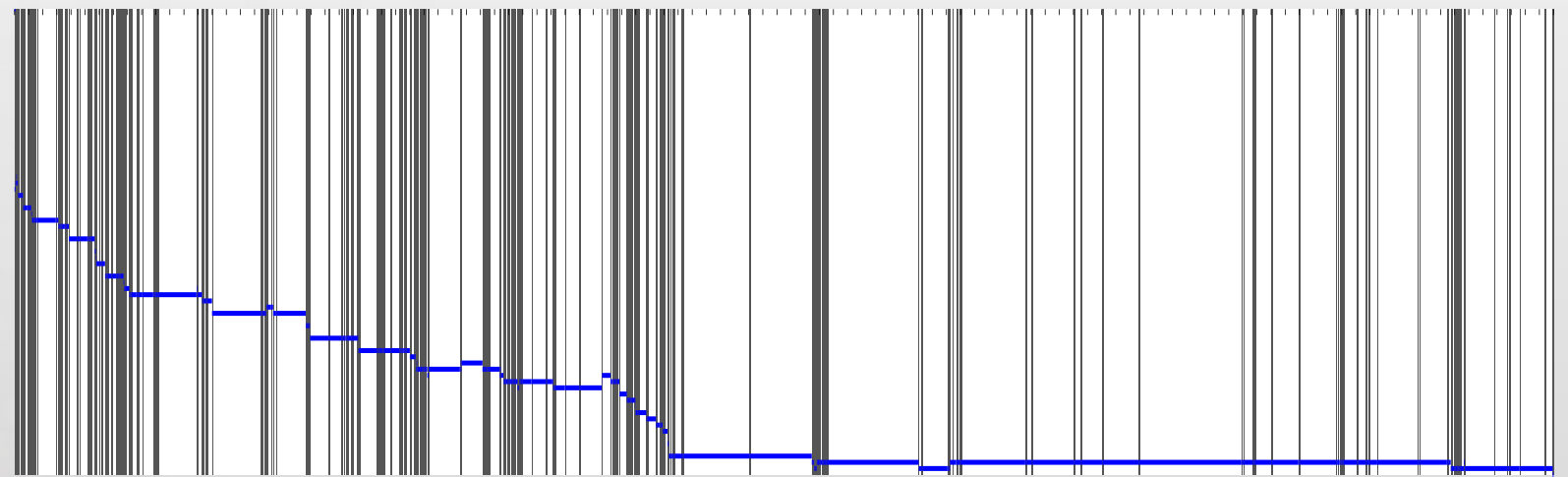
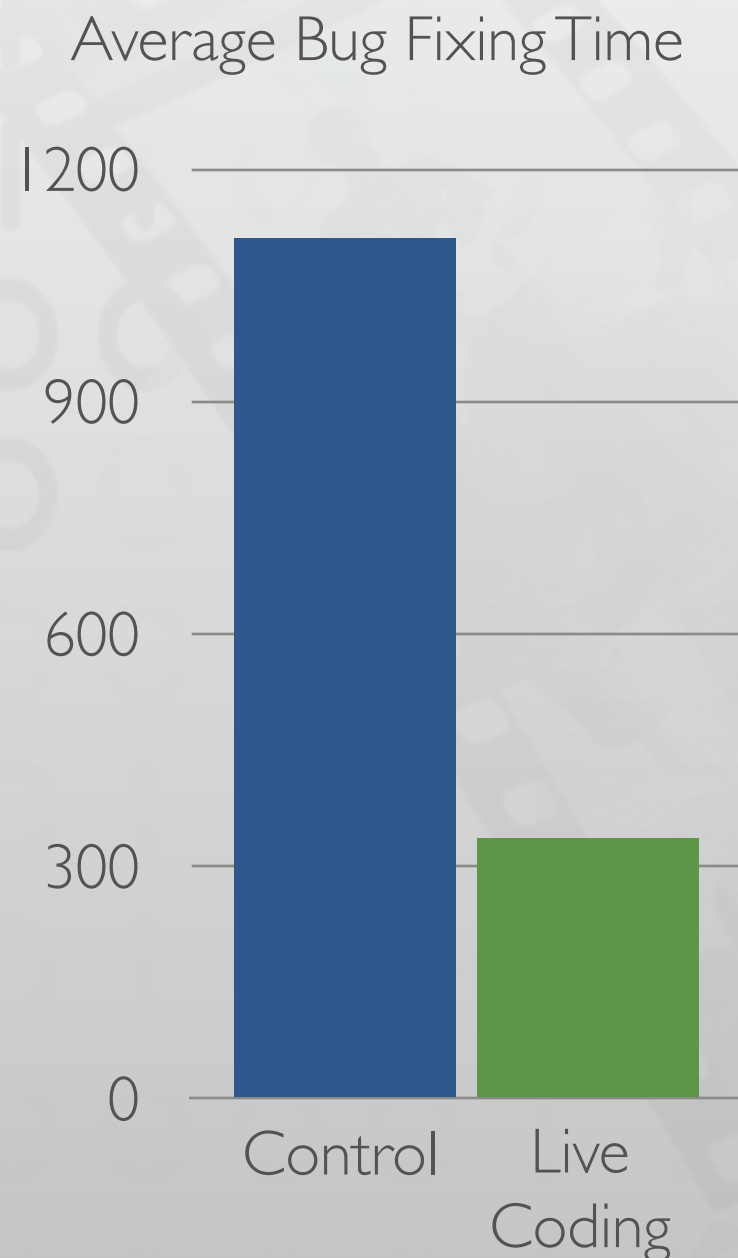
*undefined*  
[< 1/4 >] 1 truthy(true)  
1

[< 1/1 >] truthy(true)  
6  
2  
6  
0

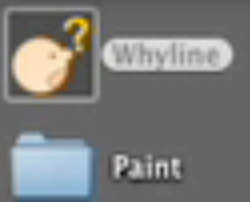
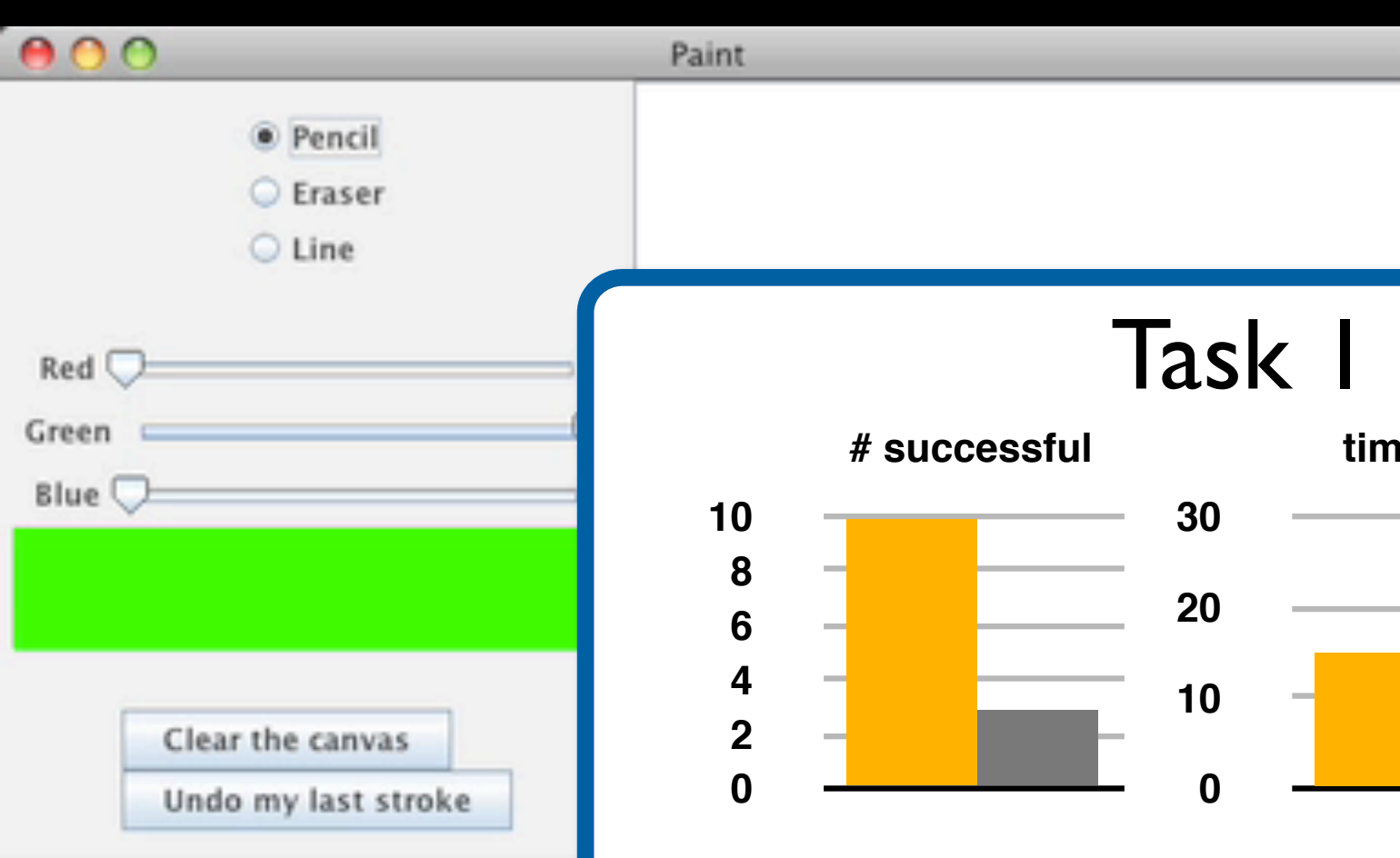
[2, 3, 4, 6, 8]

# Live Coding Affects Coding Behavior

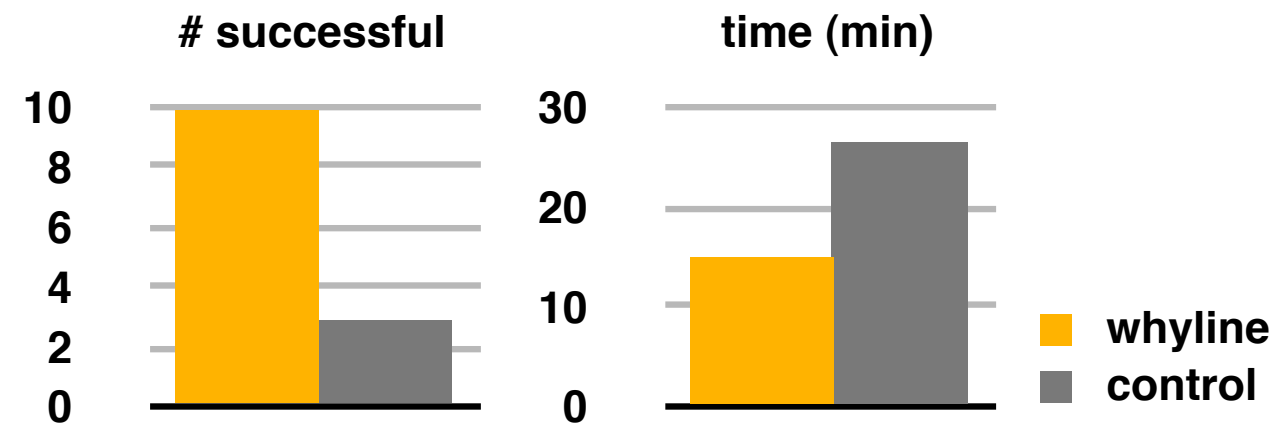
[Krämer2014, How Live Coding Affects Developers' Coding Behavior]



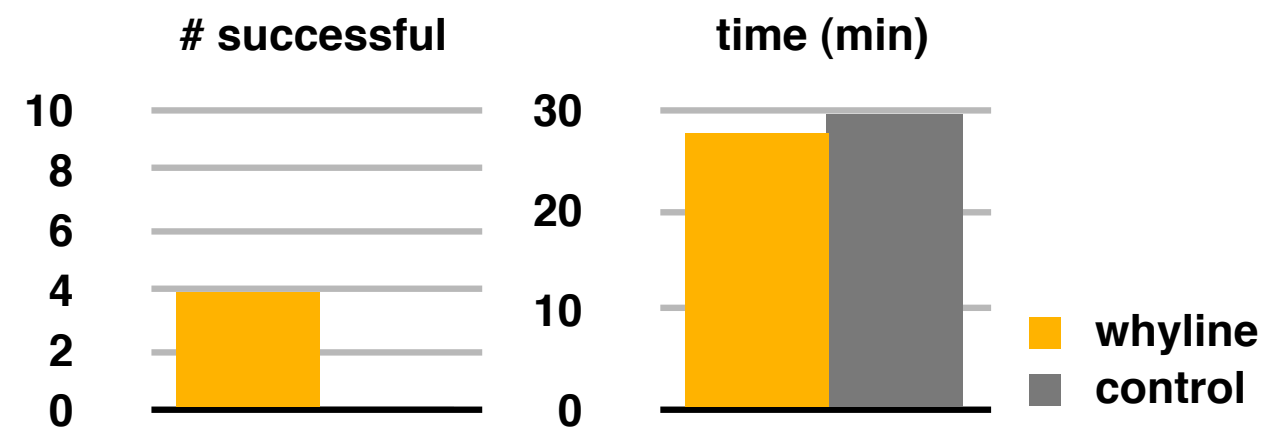




## Task 1



## Task 2



The Lorax on Blu-Ray

Television

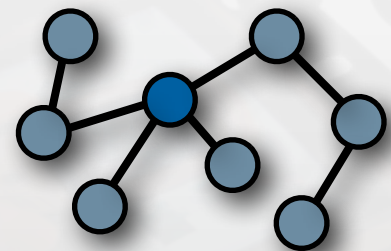
Toaster

Coconut Water

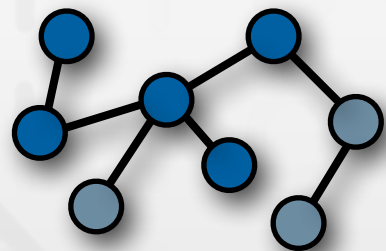
Hulk Action Figure

```
41 <script>
42 var items = ["The DaVinci
43 var basketItems = [];
44
9 calls function displayItem(nam
46     var item = $("<div c
47     item.draggable({
48         appendTo: "body"
49         helper: "clone",
0 calls     drag: function (
51         console.log(
52     },
0 calls     stop: function (
54         console.log(
55     },
56     ));
57 }
58
```

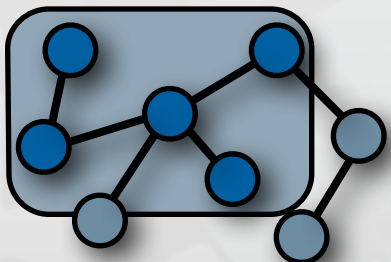
# Summary



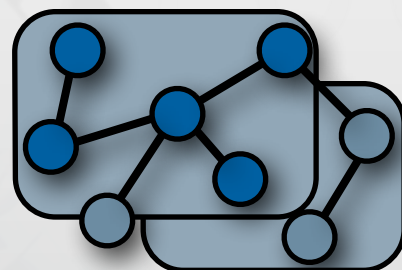
Finding focus points



Expanding focus points



Understanding a subgraph



Questions over groups of subgraphs

