Using Bug Databases for Software Engineering Estimation

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Rahul Premraj

Thomas Zimmermann

Andreas Zeller

Saarland University
Saarbrücken, Germany

Development vs. Debugging

Development vs. Debugging

Software Development
is a construction process...

Development vs. Debugging

Software Development
is a construction process...

Debugging is a
search process...

Typical Open Source Scenario

Project Manager

Typical Open Source Scenario

Project Manager

Bug Report

Bug Report

Bug Report

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Bug Report

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Bug Report

Typical Open Source Scenario

Project Manager

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Bug Report

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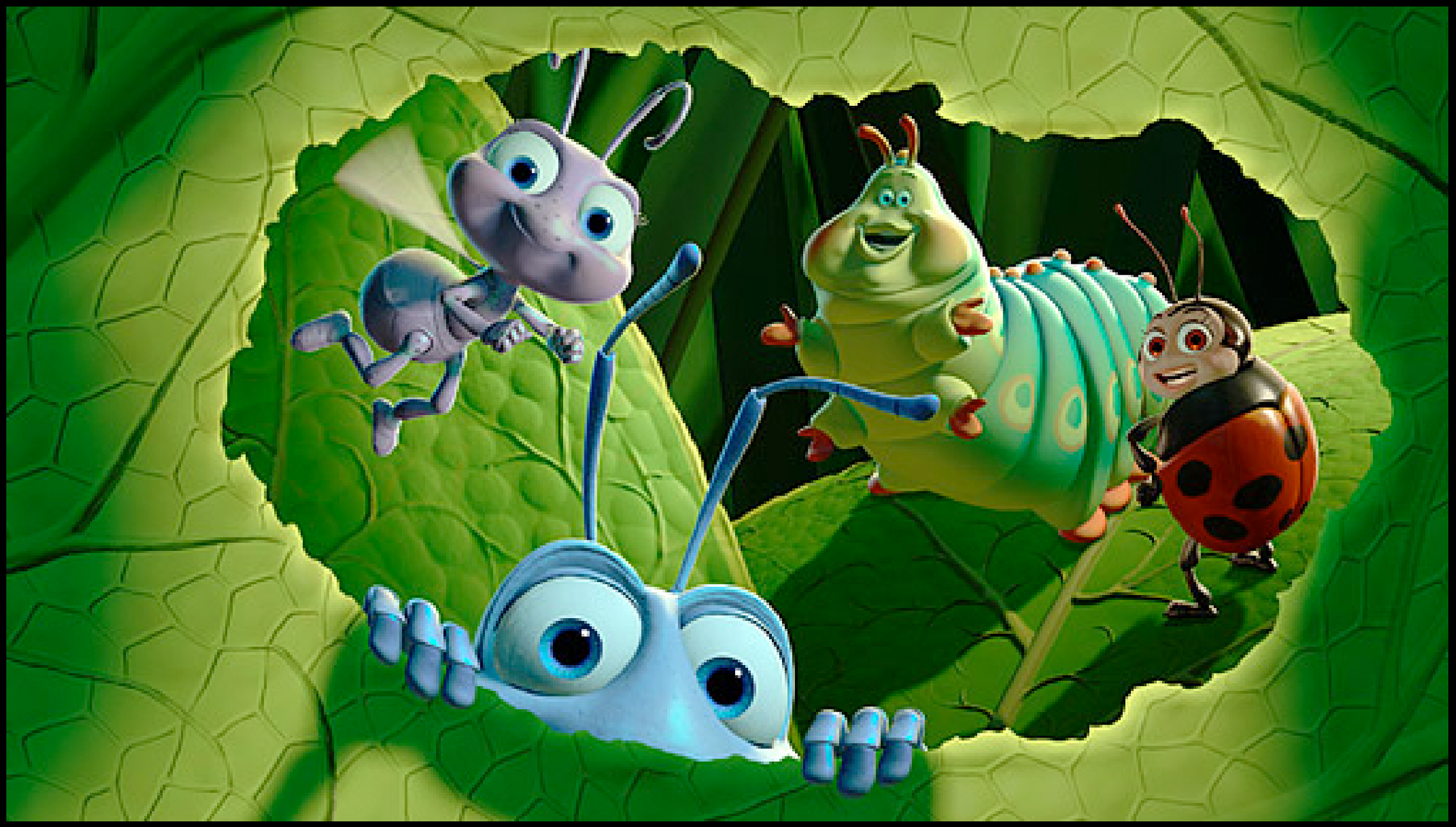
Bug Report

Typical Open Source Scenario

Project Manager

How long will it take to fix a bug?

A Bug's Life



A Bug's Life

A Bug's Life

User encounters an error

A Bug's Life

User encounters an error

No idea what to do?

A Bug's Life

User encounters an error

Take slightly extreme measures

A Bug's Life

User encounters an error

Report the bug!

A Bug's Life

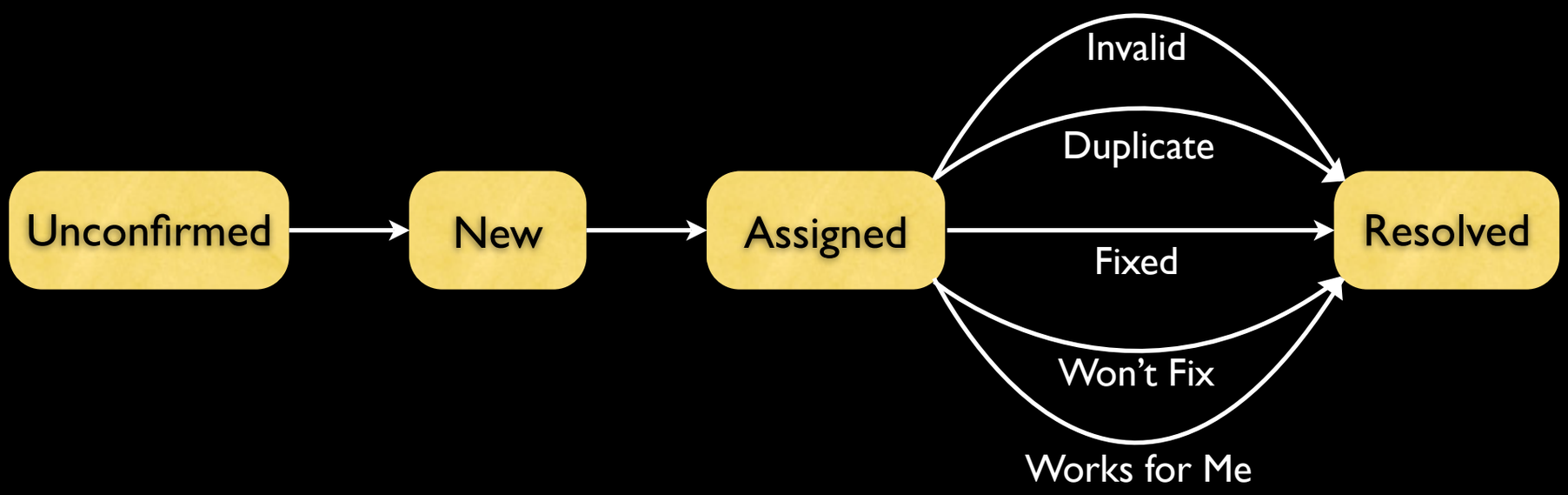
A Bug's Life

Unconfirmed

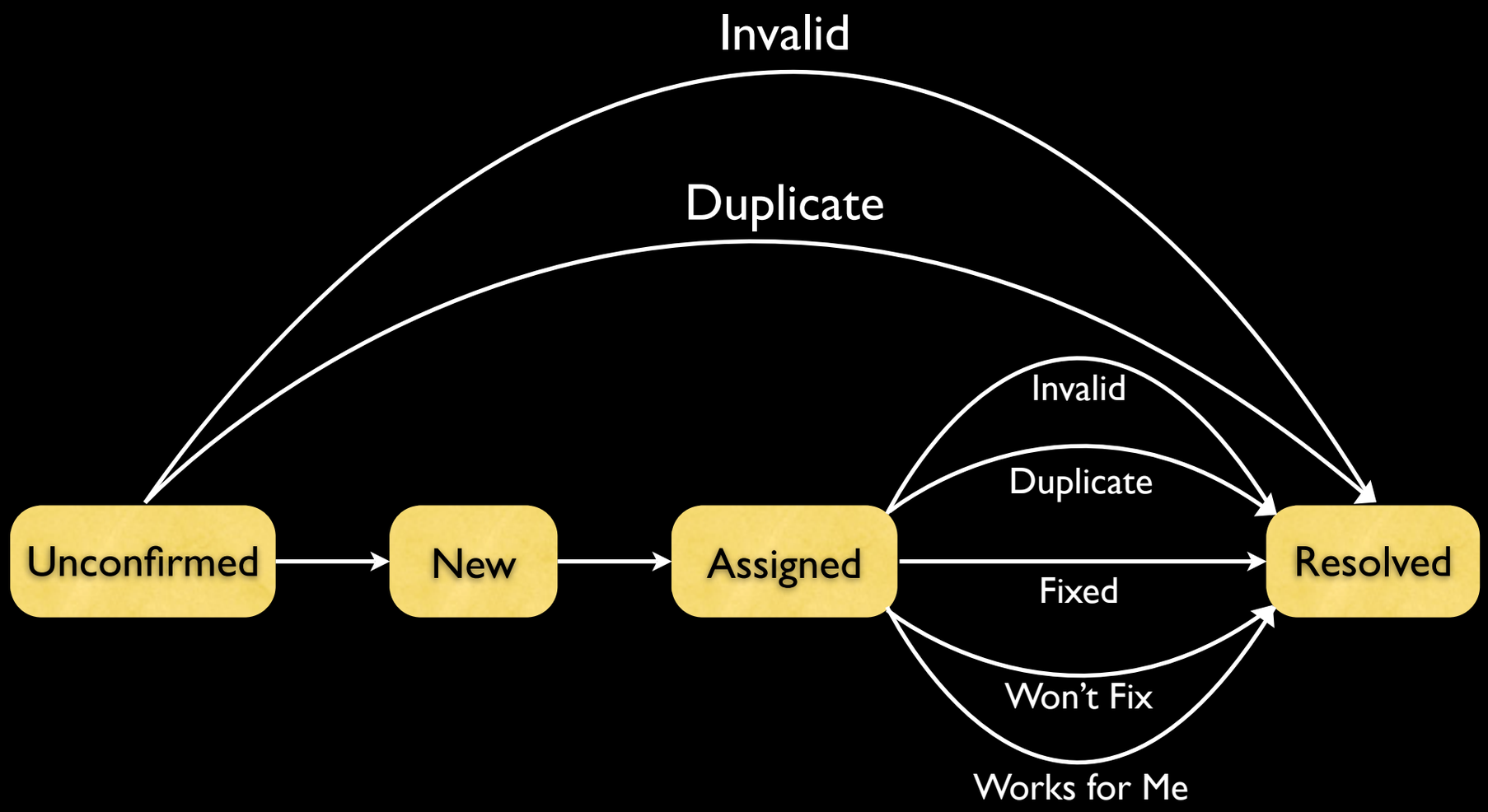
A Bug's Life

A Bug's Life

A Bug's Life


Unconfirmed
New
Assigned
Resolved
Invalid
Duplicate
Fixed
Won't Fix
Works for Me

A Bug's Life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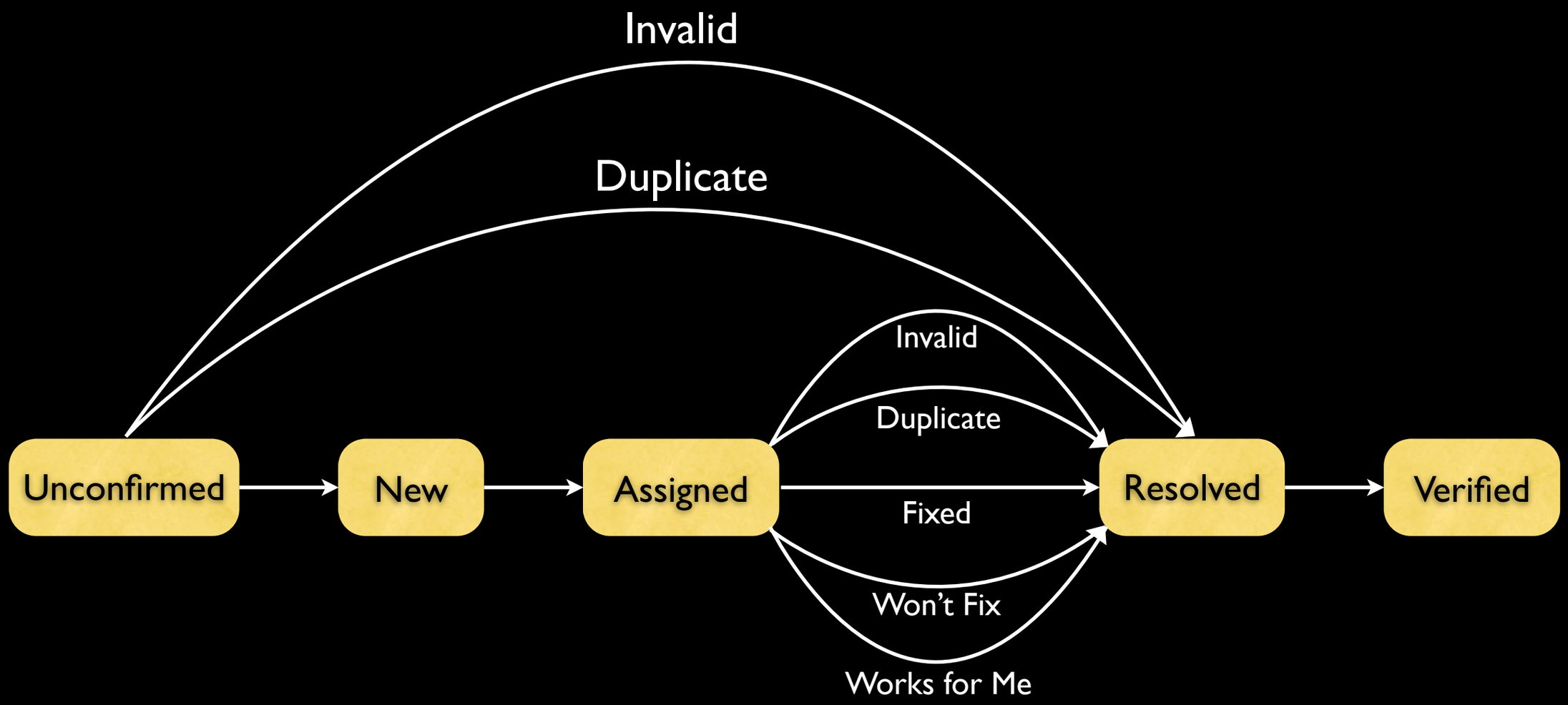
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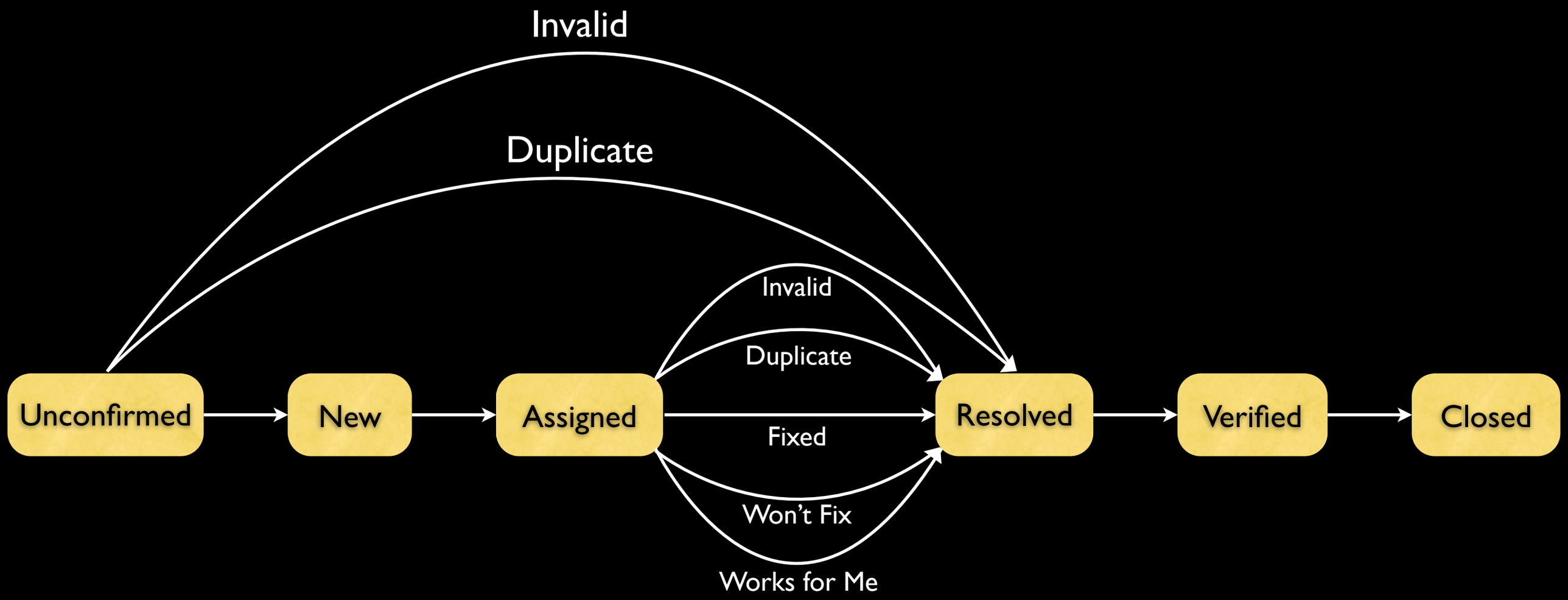
Invalid
Duplicate
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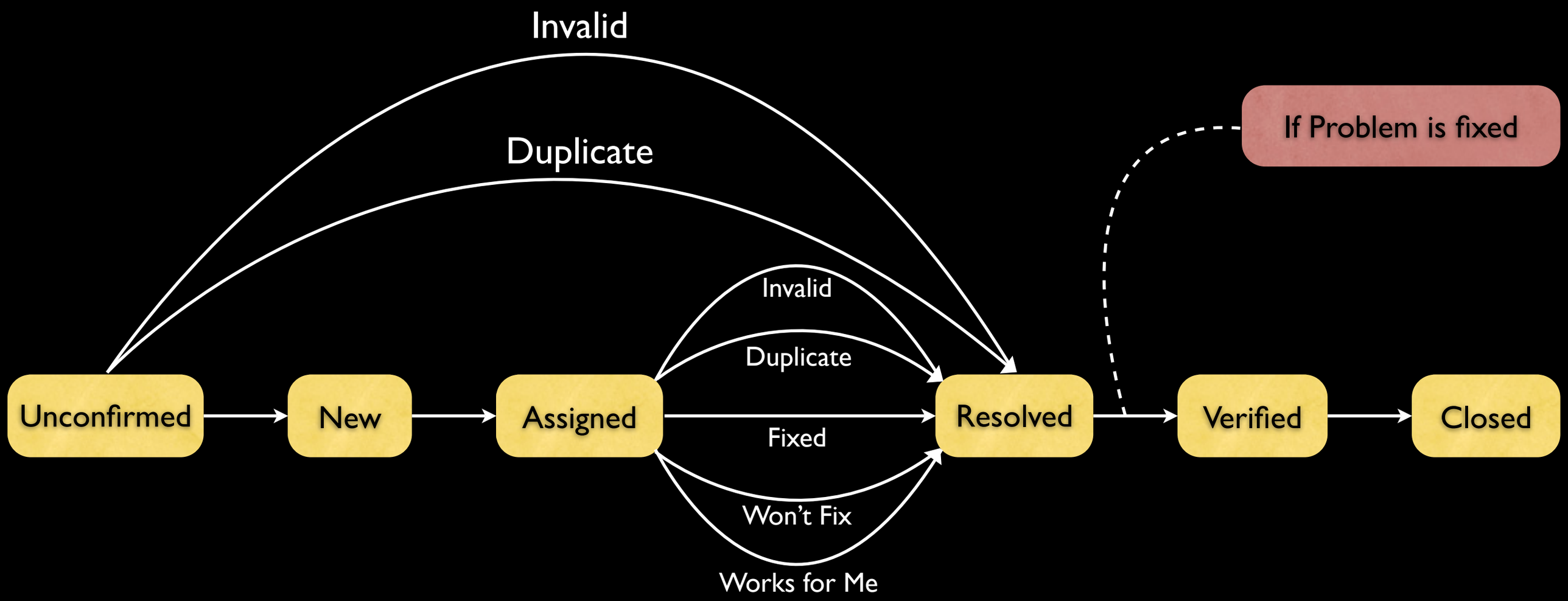
Duplicate
Fixed
Won't Fix
Works for Me
Unconfirmed
New
Assigned
Resolved
Verified
Closed

A Bug's Life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If Problem is fixed
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Duplicate
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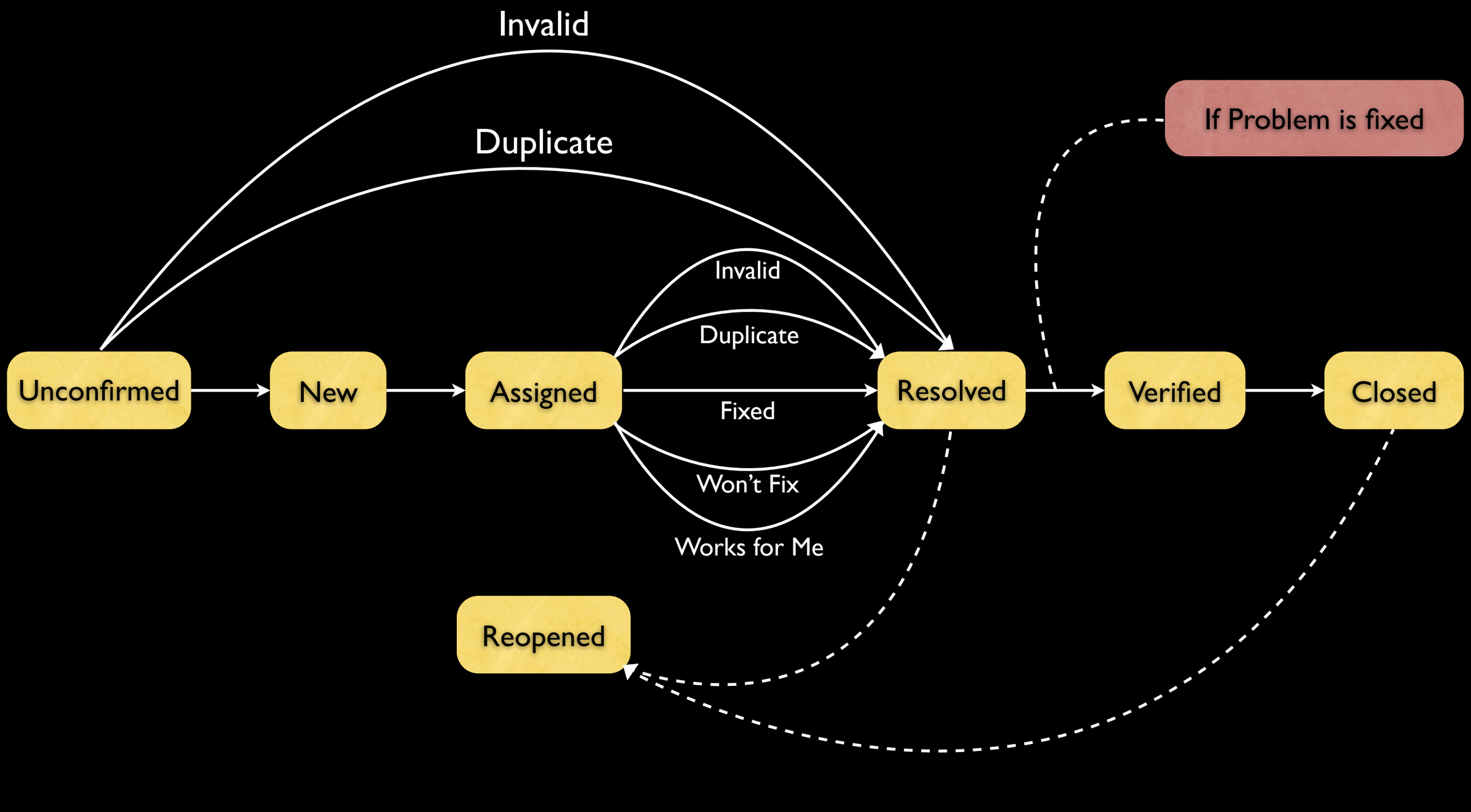
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Duplicate
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Invalid
Duplicate
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Won't Fix
Works for Me
Reopened

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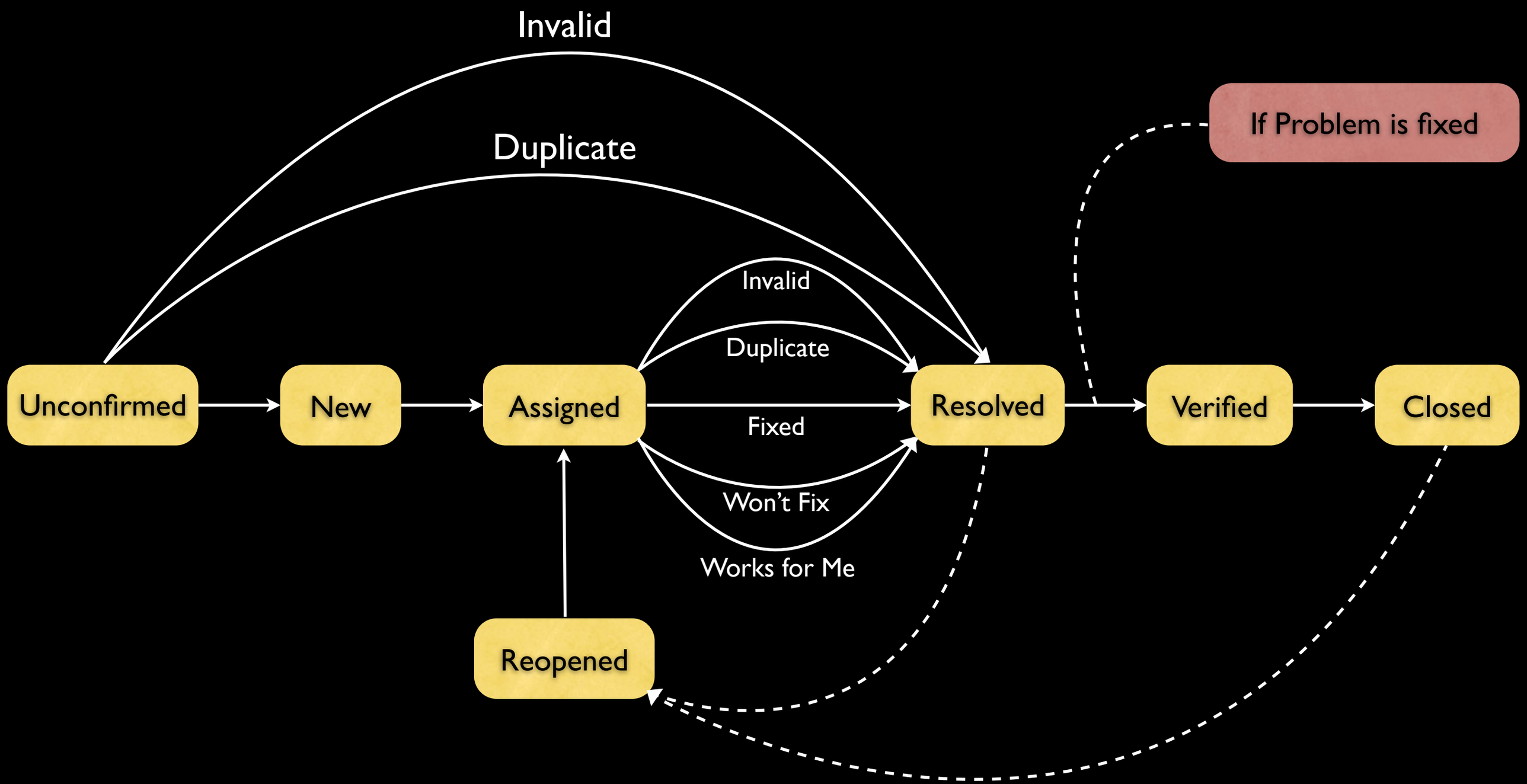
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JIRA

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JIRA

A commercial tool for

Bug Tracking, Issue Tracking and Project Management

Developed by Atlassian

www.atlassian.com/software/jira

JIRA

Other popular bug trackers...

Bugzilla

PRTRACKER™

Bug ment

Developed by Atlassian

www.atlassian.com/software/jira

JIRA

Issue Details (XML | Word)

Key:	JBAS-3054
Type:	Bug
Status:	Resolved
Resolution:	Done
Priority:	Major
Assignee:	Anil Saldhana
Reporter:	Scott M Stark
Votes:	0
Watchers:	0

Operations

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JBoss Application Server

Use of isUserInRole from jsp does not work for JACC

Return to search

Created: 04/Apr/06 03:17 PM Updated: 22/Apr/06 02:37 AM

Component/s:	Security, Web (Tomcat) service
Affects Version/s:	JBossAS-4.0.4.CR2
Fix Version/s:	JBossAS-5.0.0.Beta, JBossAS-4.0.4.GA
Security Level:	Public (Everyone can see)

Original Estimate:	4 hours	**Remaining Estimate:**	0 minutes	**Time Spent:**	1 day, 2 hours
Environment:	org.jboss.test.web.test.UserInRoleUnitTestCase(JACC).testConflictingUserInRole				

JBoss Forum Reference:	http://www.jboss.com/index.html?module=bb&op=viewtopic&t=81475

Description « Hide

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All | Comments | Work Log | Change History | FishEye Sort Order:

Dimitris Andreadis [14/Apr/06 05:50 AM] [Permlink | « Hide]

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Details

History | Log In

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Fix Version/s:	JBossAS-5.0.0.Beta, JBossAS-4.0.4.GA
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Created: 04/Apr/06 03:17 PM Updated: 22/Apr/06 02:37 AM

Return to search

Component/s:	Security, Web (Tomcat) service
Affects Version/s:	JBossAS-4.0.4.CR2
Fix Version/s:	JBossAS-5.0.0.Beta, JBossAS-4.0.4.GA
Security Level:	Public (Everyone can see)

Original Estimate:	4 hours	**Remaining Estimate:**	0 minutes	**Time Spent:**	1 day, 2 hours
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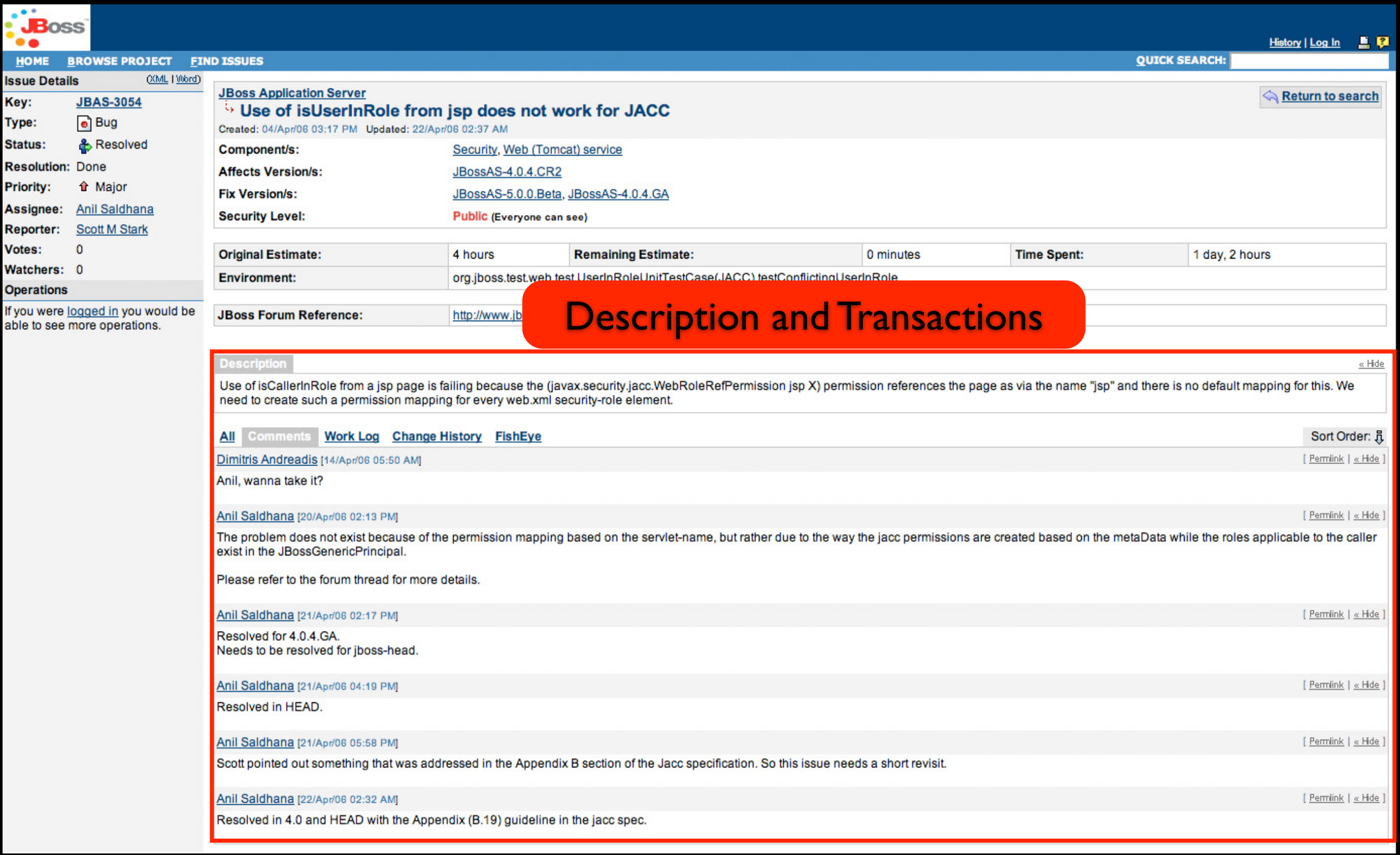
JBoss
History | Log In
HOME
BROWSE PROJECT
FIND ISSUES
QUICK SEARCH:
Issue Details
(XML | Word)
Key: JBAS-3054
Type: Bug
Status: Resolved
Resolution: Done
Priority: Major
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Reporter: Scott M Stark
Votes: 0
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Component/s: Security, Web (Tomcat) service
Affects Version/s: JBossAS-4.0.4.CR2
Fix Version/s: JBossAS-5.0.0.Beta, JBossAS-4.0.4.GA
Security Level: Public (Everyone can see)
Original Estimate: 4 hours
Remaining Estimate: 0 minutes
Time Spent: 1 day, 2 hours
Environment: org.jboss.test.web.test.UserInRoleUnitTestCase(JACC).testConflictingUserInRole
JBoss Forum Reference:
Description and Transactions
Description
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Affects Version/s:	JBossAS-4.0.4.CR2
Fix Version/s:	JBossAS-5.0.0.Beta, JBossAS-4.0.4.G
Security Level:	Public (Everyone can see)

Effort Data

Original Estimate:	4 hours	**Remaining Estimate:**	0 minutes	**Time Spent:**	1 day, 2 hours
Environment:	org.jboss.test.web.test.UserInRoleUnitTestCase(JACC).testConflictingUserInRole				

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Case Based Prediction

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Similar problems have similar solutions...

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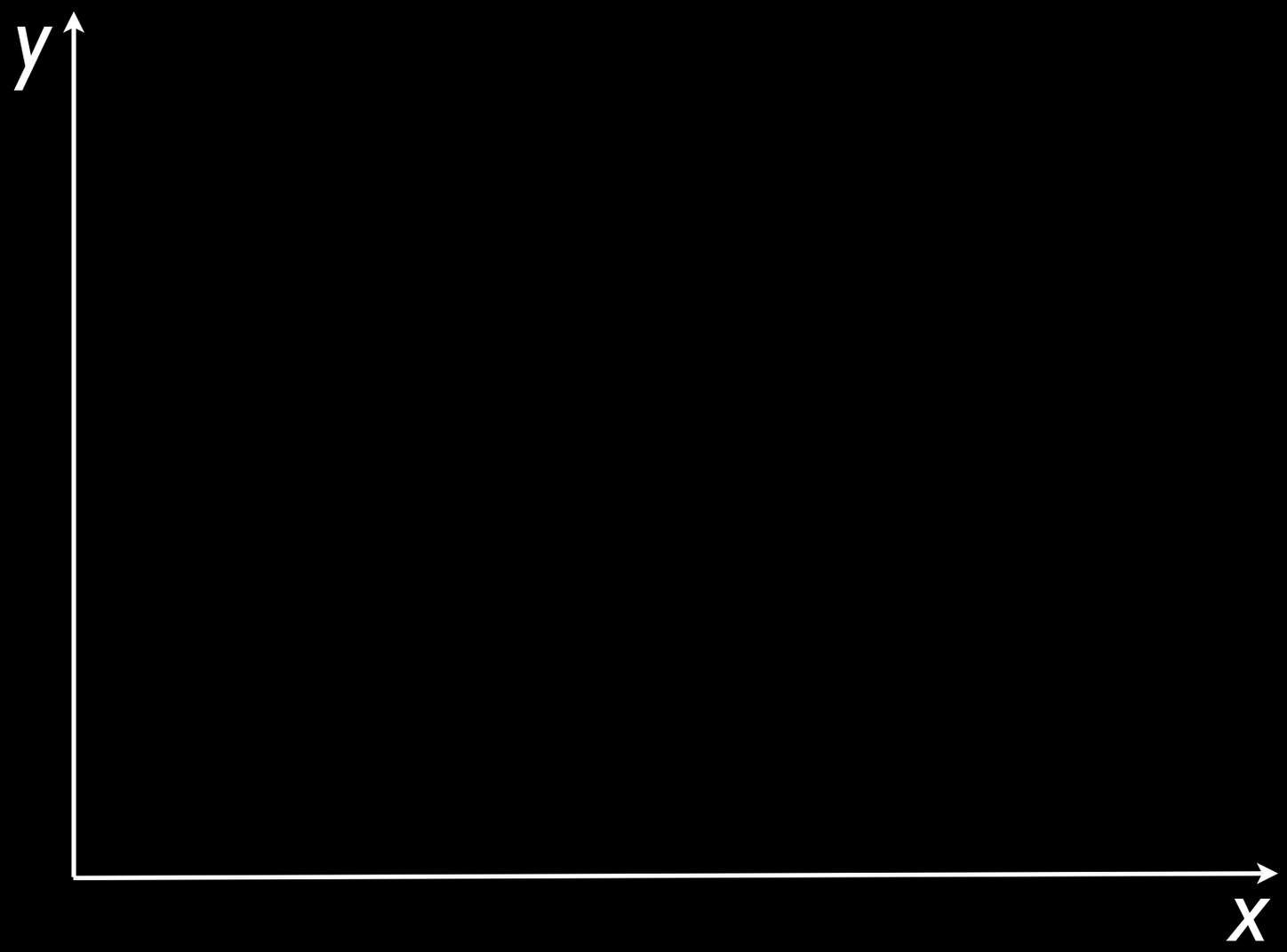

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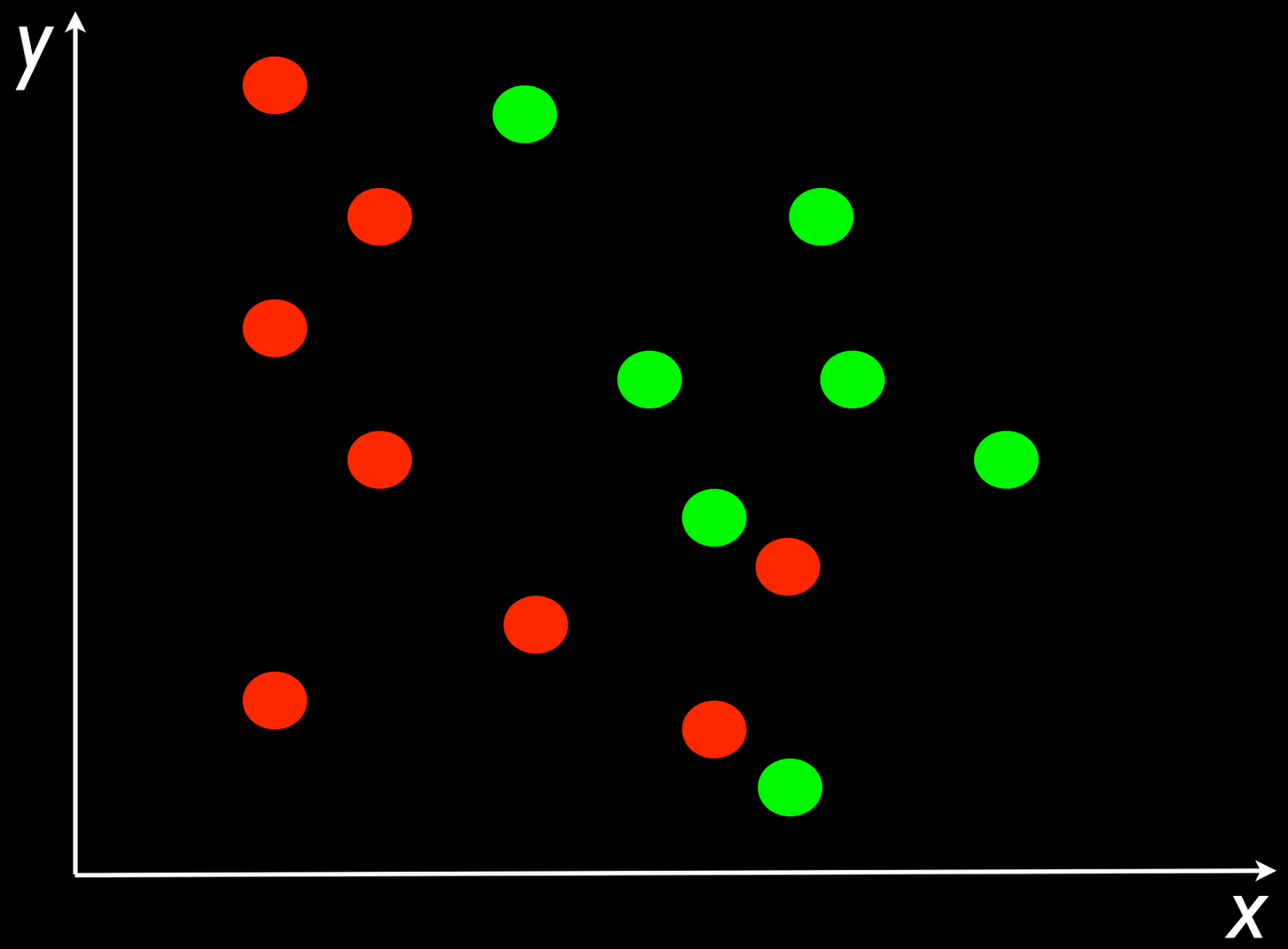

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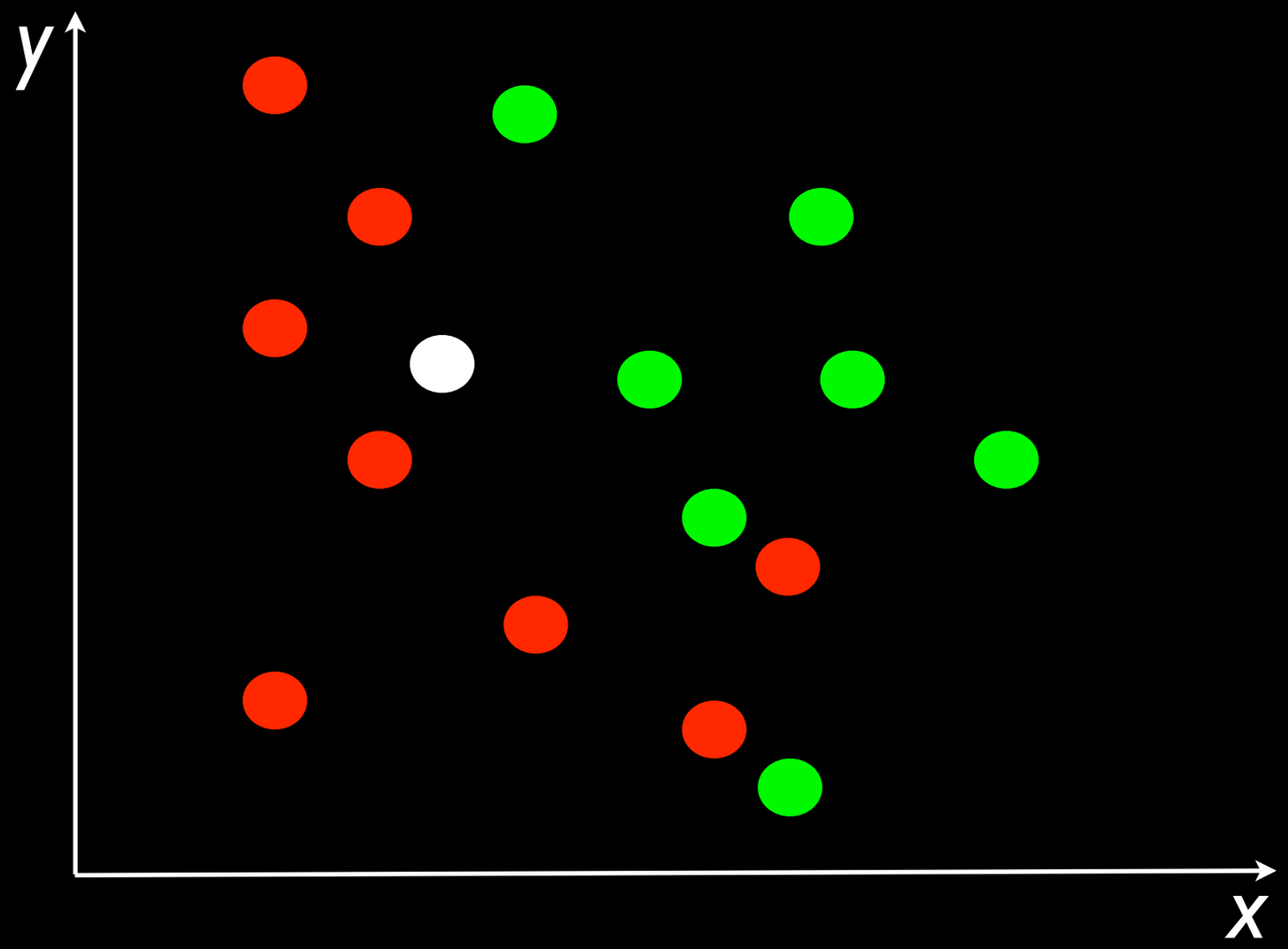
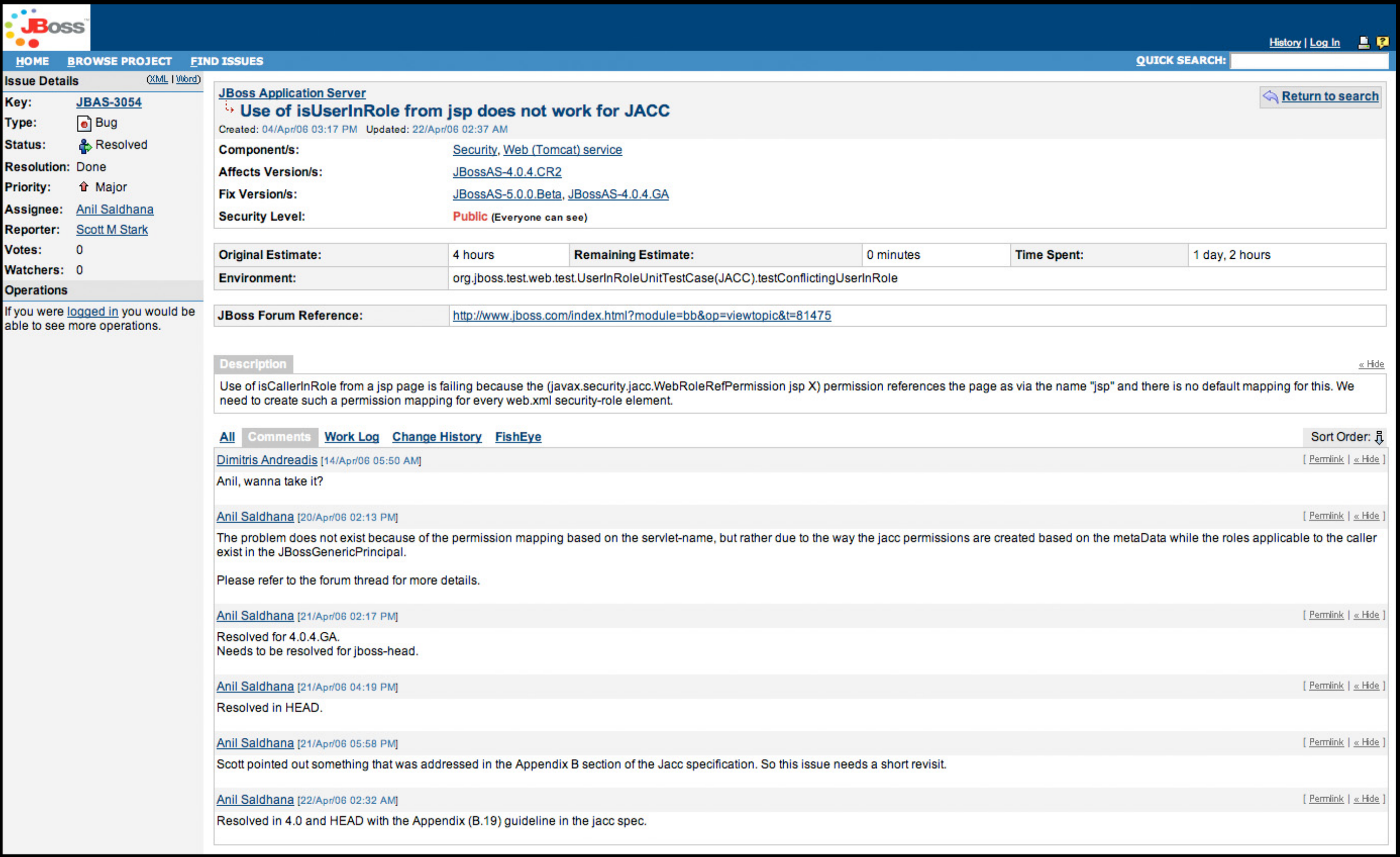


Input Data



JBoss

History | Log In

HOME BROWSE PROJECT FIND ISSUES QUICK SEARCH:

Issue Details (XML | Word)

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Status: Resolved
Resolution: Done
Priority: Major
Assignee: Anil Saldhana
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Component/s:	Security, Web (Tomcat) service
Affects Version/s:	JBossAS-4.0.4.CR2
Fix Version/s:	JBossAS-5.0.0.Beta, JBossAS-4.0.4.GA
Security Level:	Public (Everyone can see)

Original Estimate:	4 hours	**Remaining Estimate:**	0 minutes	**Time Spent:**	1 day, 2 hours
Environment:	org.jboss.test.web.test.UserInRoleUnitTestCase(JACC).testConflictingUserInRole				

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One Line Summary

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Lucene

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a text similarity computing tool

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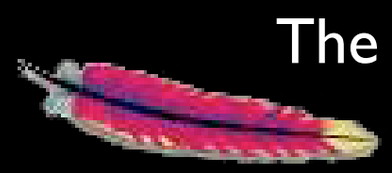
developed by



The Apache Software Foundation

http://www.apache.org

Lucene

a text similarity computing tool

developed by

The Apache Software Foundation

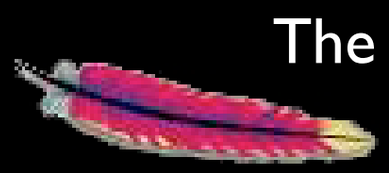
http://www.apache.org

also used by

Lucene

a text similarity computing tool

developed by



The Apache Software Foundation

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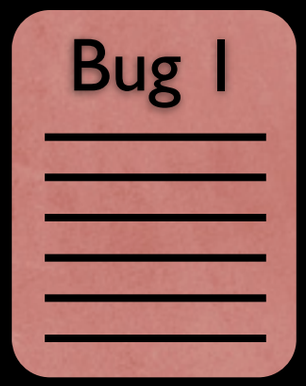
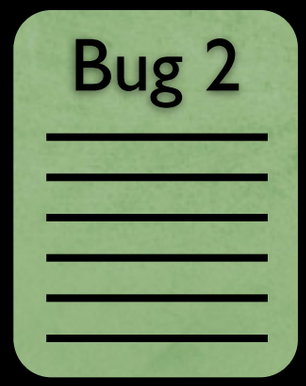
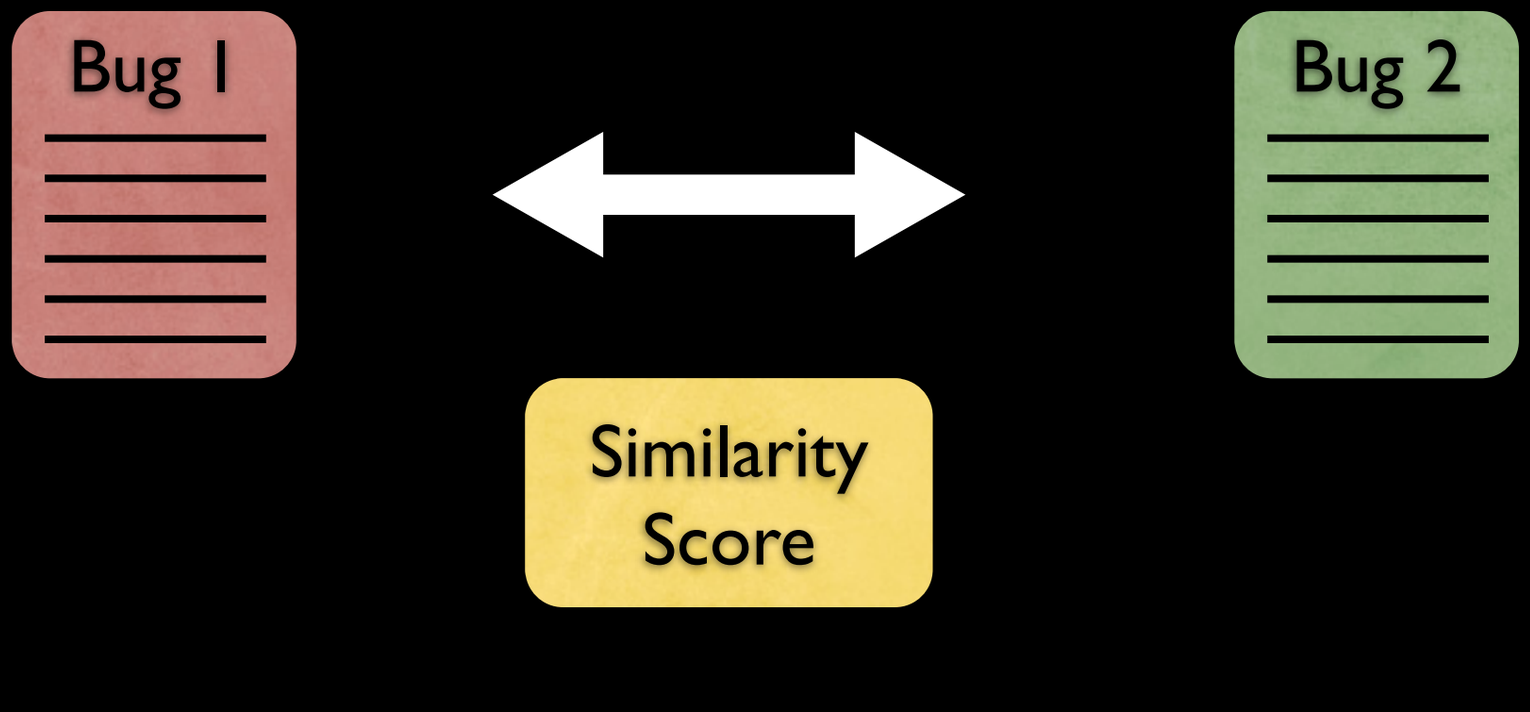
Lucene

Lucene



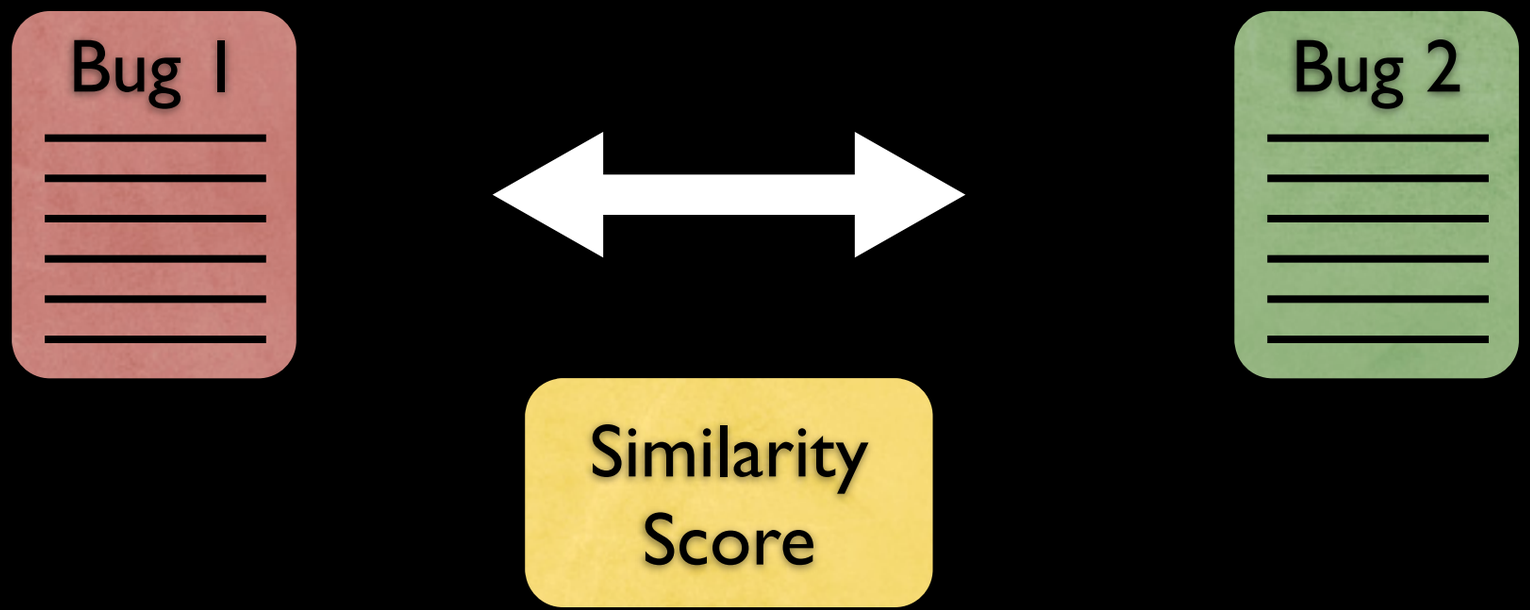


Lucene



Lucene

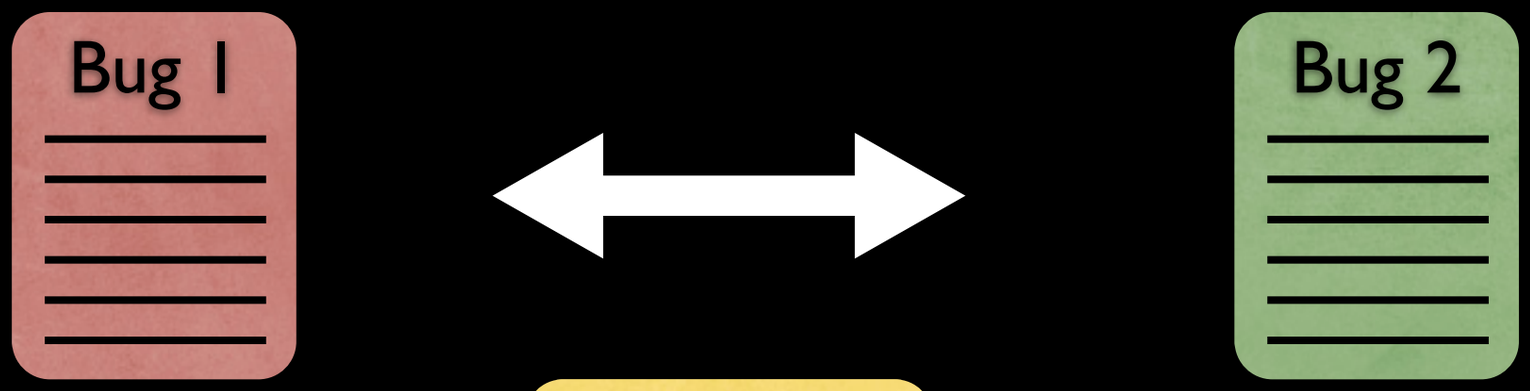
Lucene



Stemming

educate: educating, education, educated

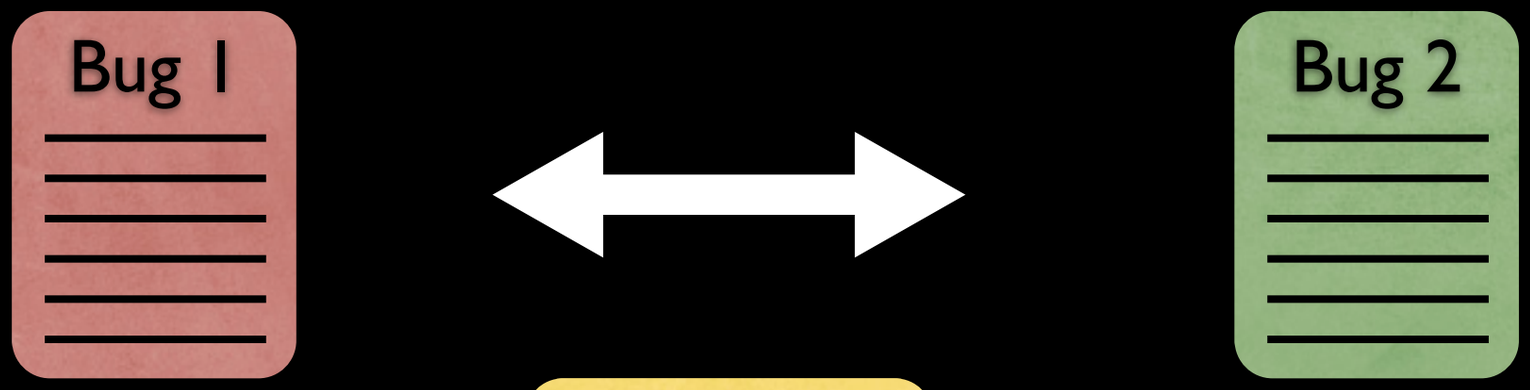
Lucene



Field Comparison

title:“The Right Way” AND text:“go”

Lucene



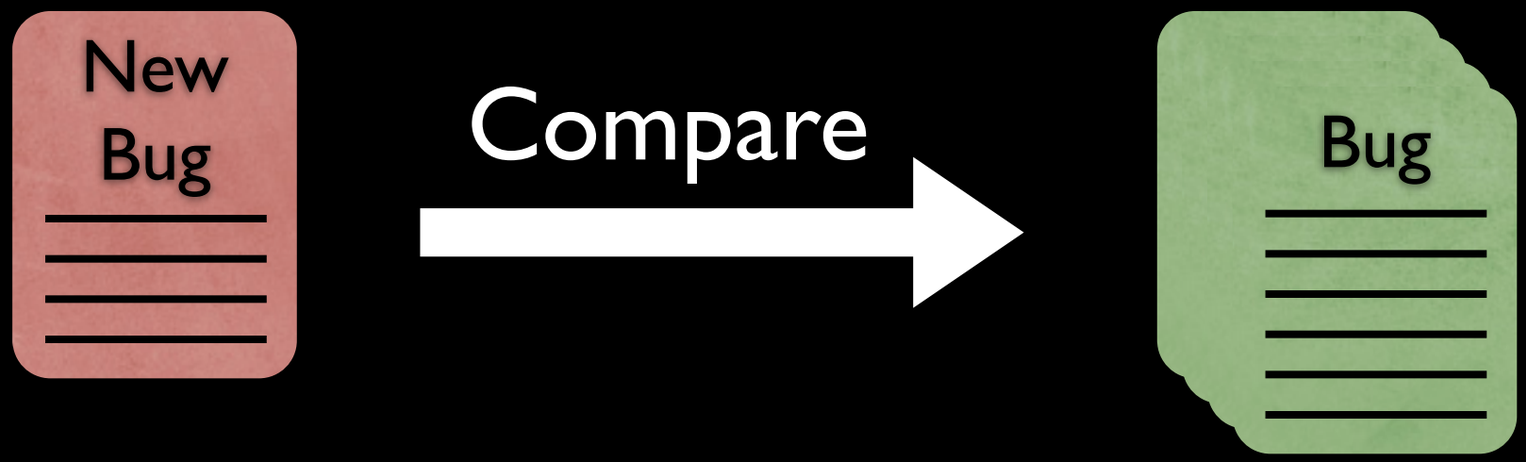
Fuzzy and Wildcard

te?t, te*t, text* roam~

Prediction Model

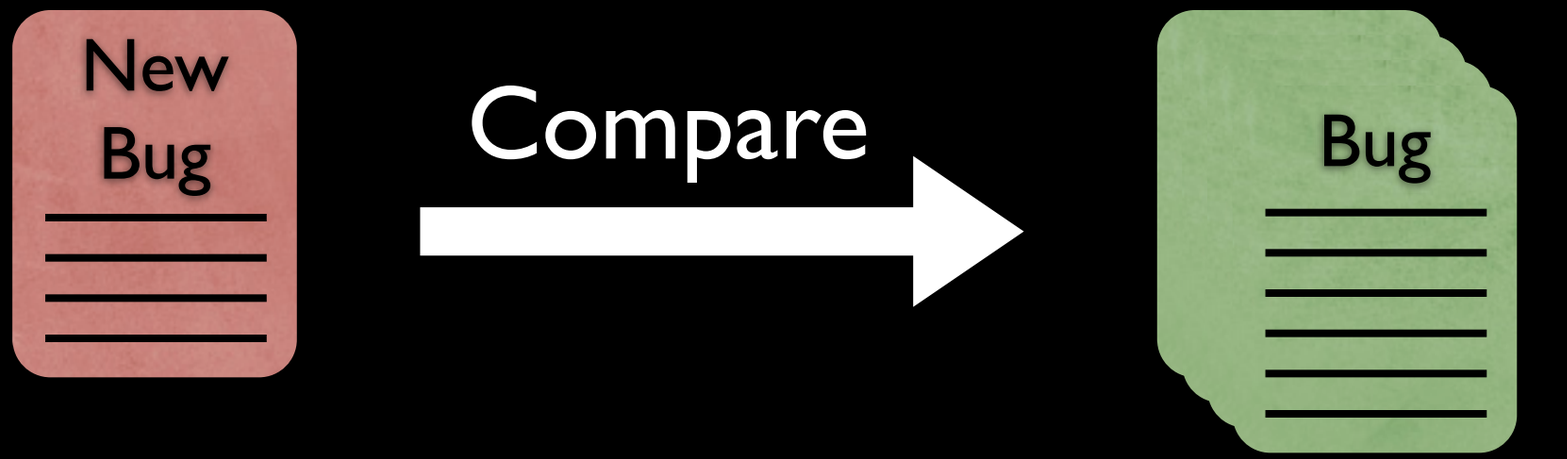
Prediction Model

Prediction Model



Prediction Model

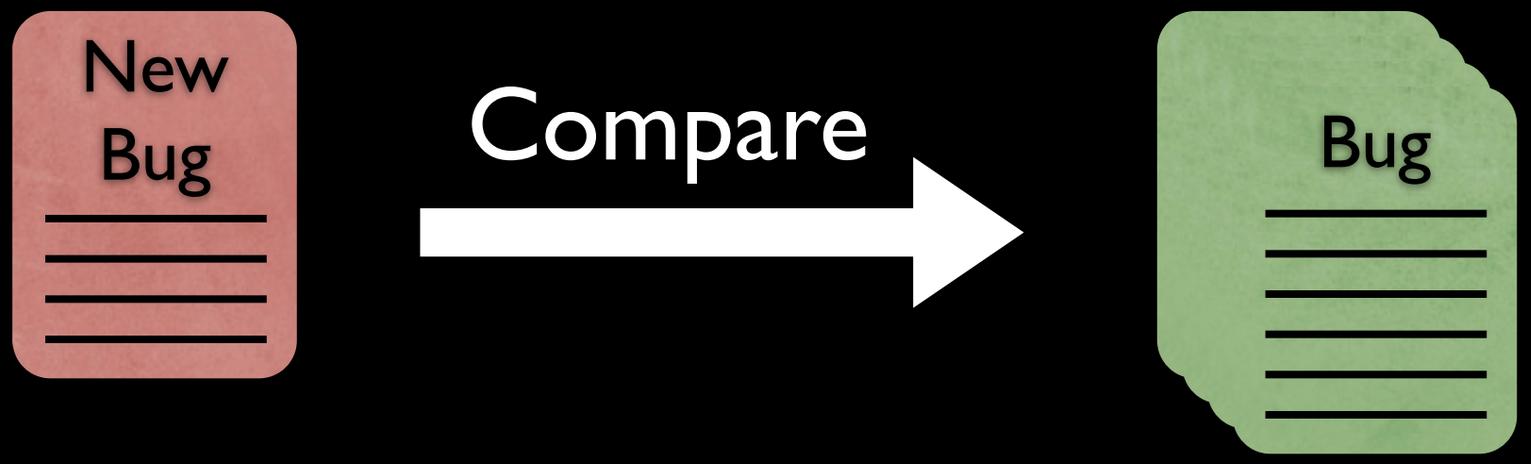
1/3rd
data set



2/3rd
data set

Prediction Model

1/3rd data set



2/3rd data set

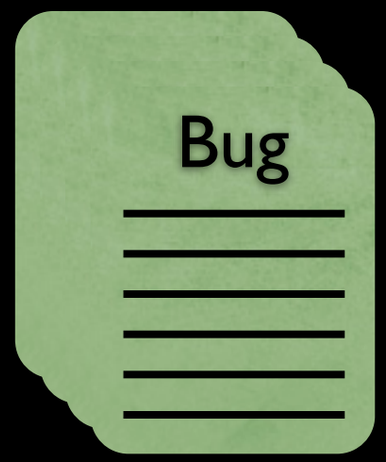
One Line Summary (S)

Description (D)

Prediction Model

1/3rd data set

Compare



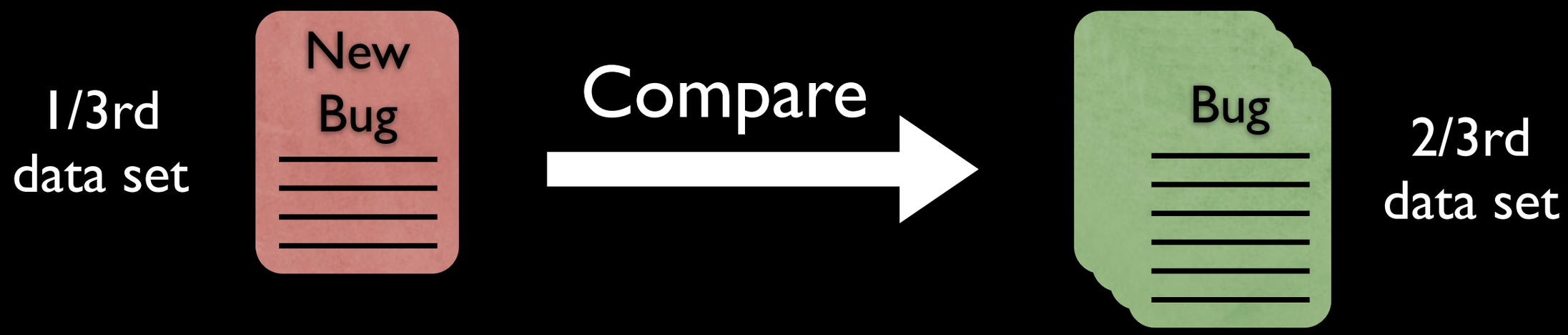
2/3rd data set

Feature Weights (1:1, 1:2, 2:1)

One Line Summary (S)

Description (D)

Prediction Model



Feature Weights (1:1, 1:2, 2:1)

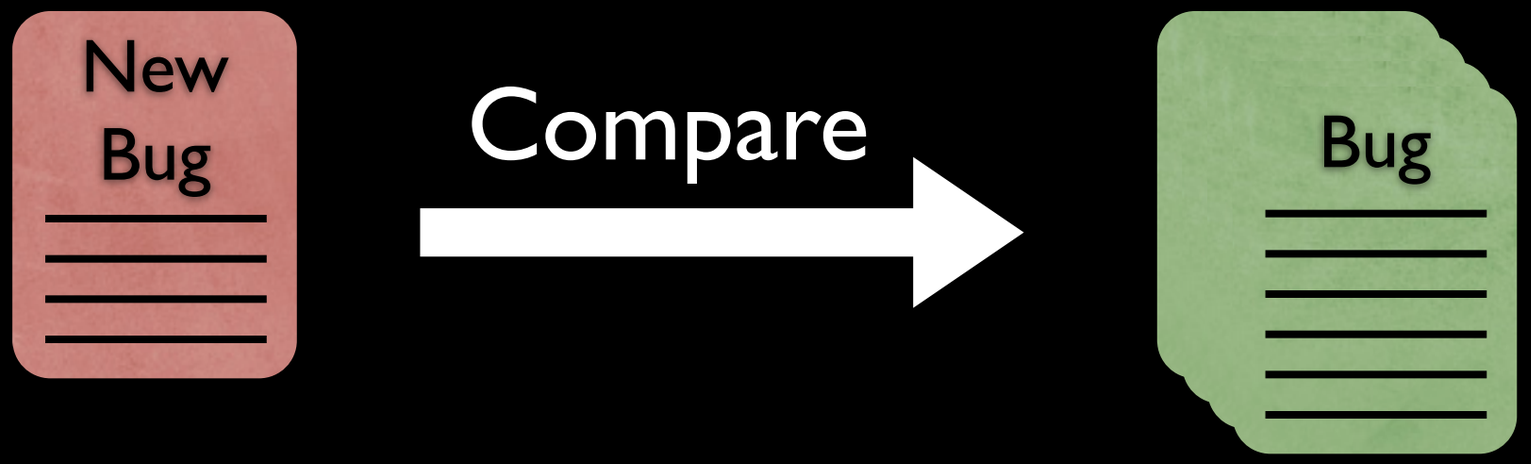
One Line Summary
(S)

Description
(D)

Average *k* nearest neighbours using simple,
distance weighted and rank-weighted average

Prediction Model

1/3rd data set



2/3rd data set

Feature Weights (1:1, 1:2, 2:1)

One Line Summary

Description

Average *k* nearest neighbours using simple, distance weighted and rank-weighted average

Prediction Model

Evaluation of Results

- Sum of Absolute Residuals
- Pred (25)
- Pred (50)

JBoss

JBoss

www.jboss.com, www.jboss.org

JBoss

www.jboss.com, www.jboss.org

a division of RedHat

JBoss

www.jboss.com, www.jboss.org

a division of RedHat

Example Products -

- JBoss Application Server
- JBoss Cache
- JBoss Portal
- JBoss Messaging
- JBoss Eclipse IDE
- ...

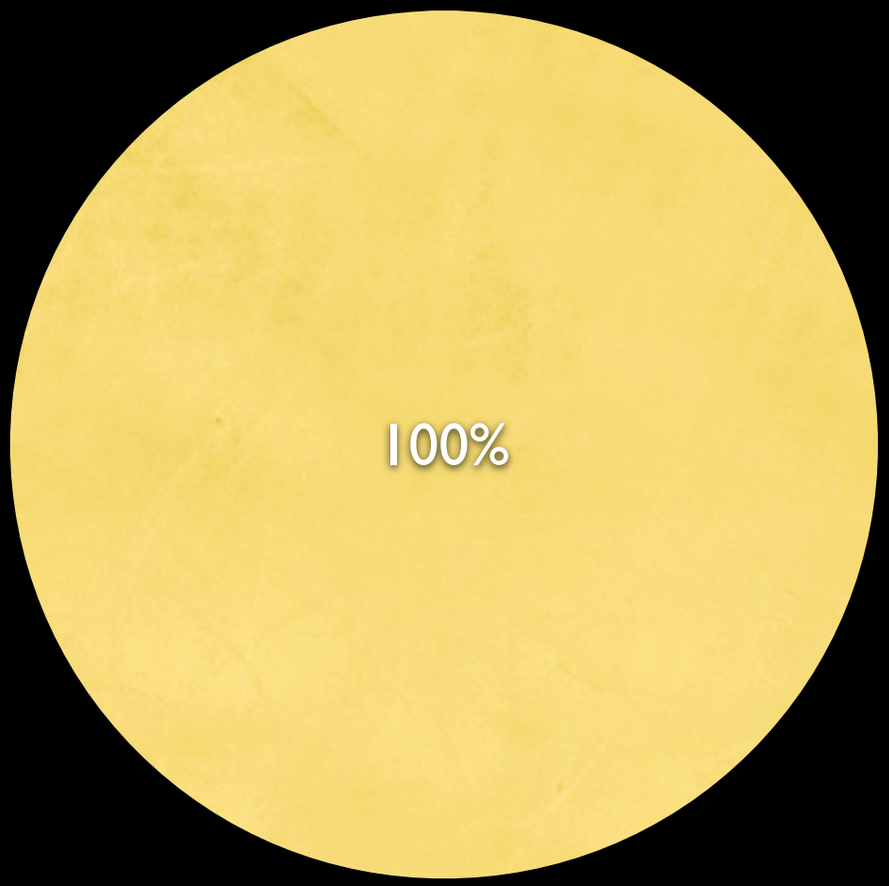
JBoss Data Set

As of 15th April 2006,

JBoss Data Set

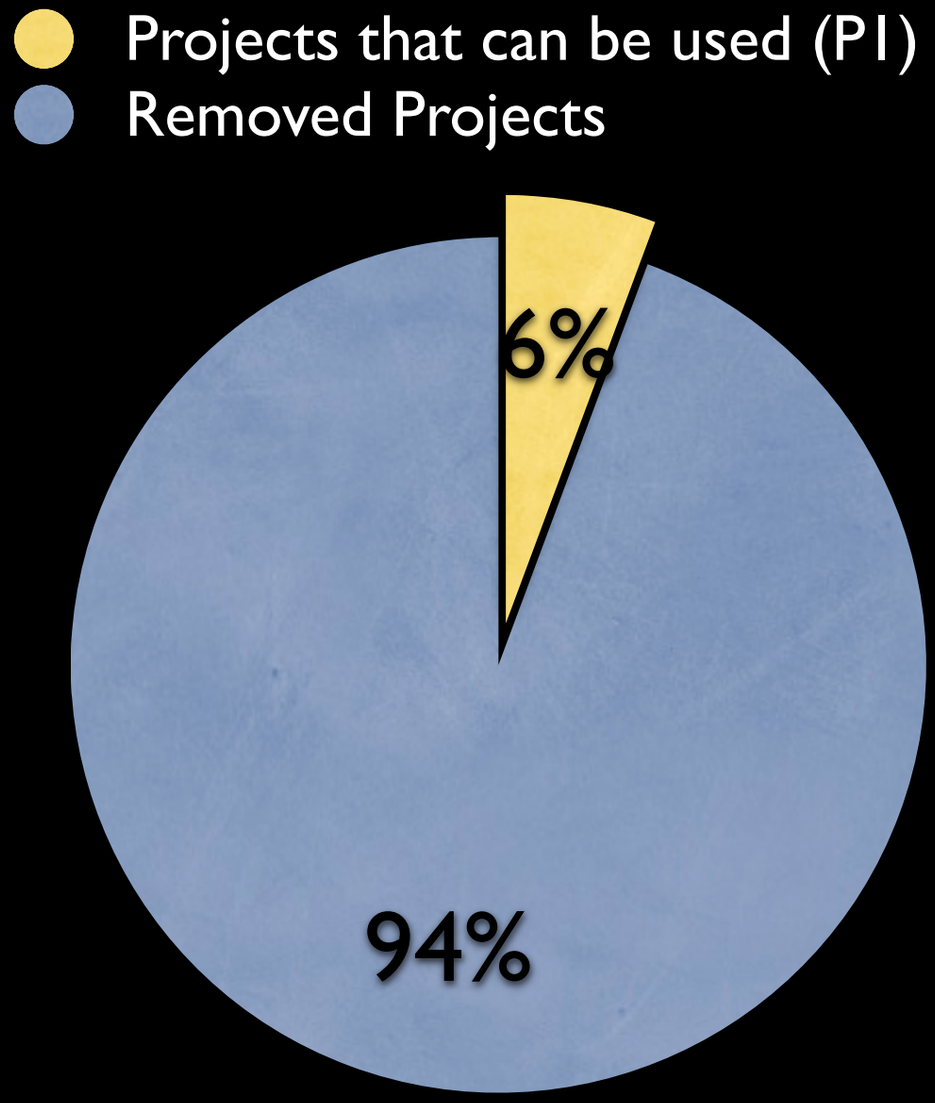
As of 15th April 2006,

- Total Number of Bugs (11185)



JBoss Data Set

As of 15th April 2006,



Results using PI

Results using PI

Using Average as a Predictor

- Sum of Absolute Residuals - 10,354 hours
- Pred (25) - 13%
- Pred (50) - 28%

Results using PI

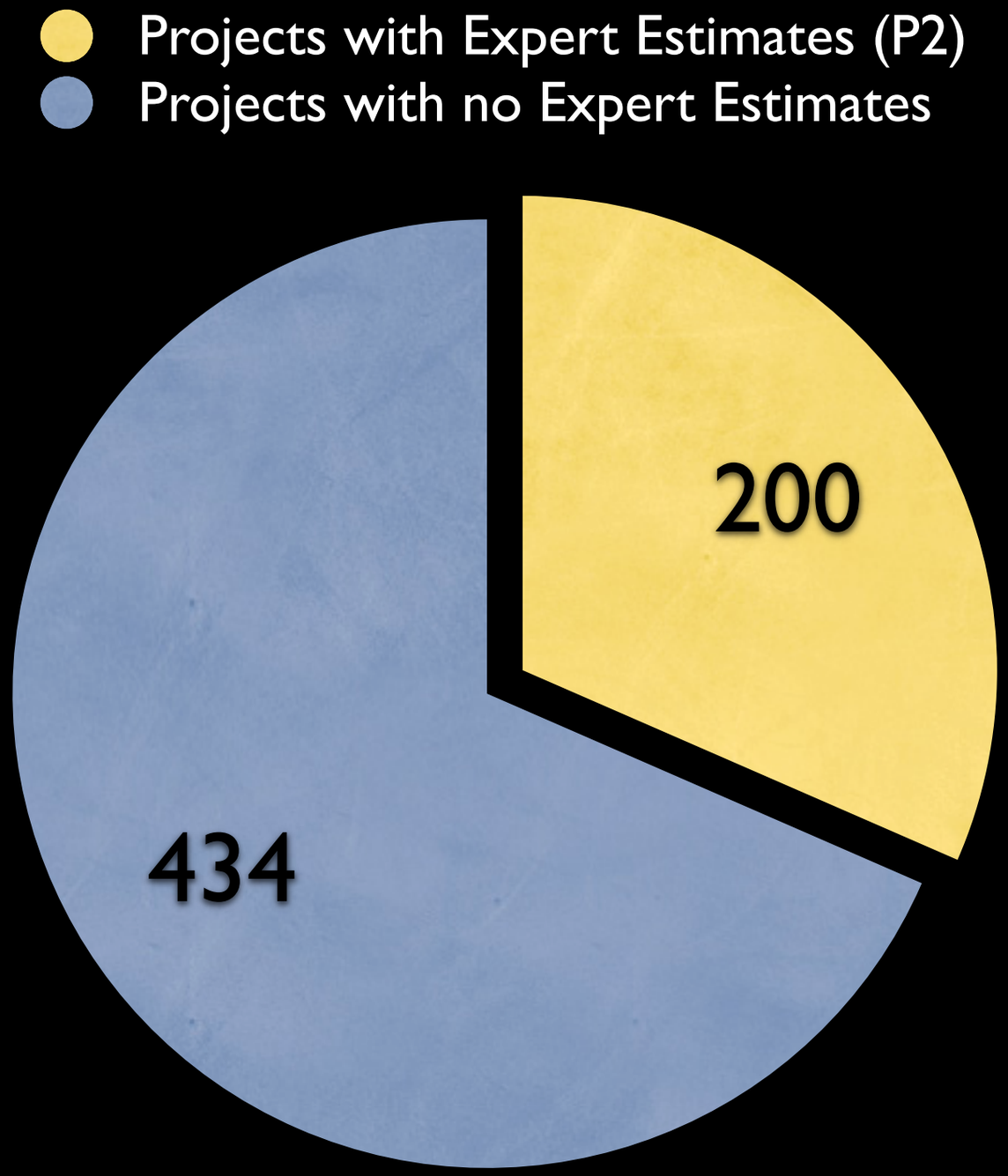
Using Average as a Predictor

- Sum of Absolute Residuals - 10,354 hours
- Pred (25) - 13%
- Pred (50) - 28%

Rank-based Avg., 2:1 (S:D) weights, *k* = 1

- Sum of Absolute Residuals - 10,451 hours
- Pred (25) - 18%
- Pred (50) - 30%

JBoss (P1) Data Set



Results using P2

Results using P2

Using Expert Estimates

- Sum of Absolute Residuals - 2,211 hours
- Pred (25) - 40%
- Pred (50) - 63%

Results using P2

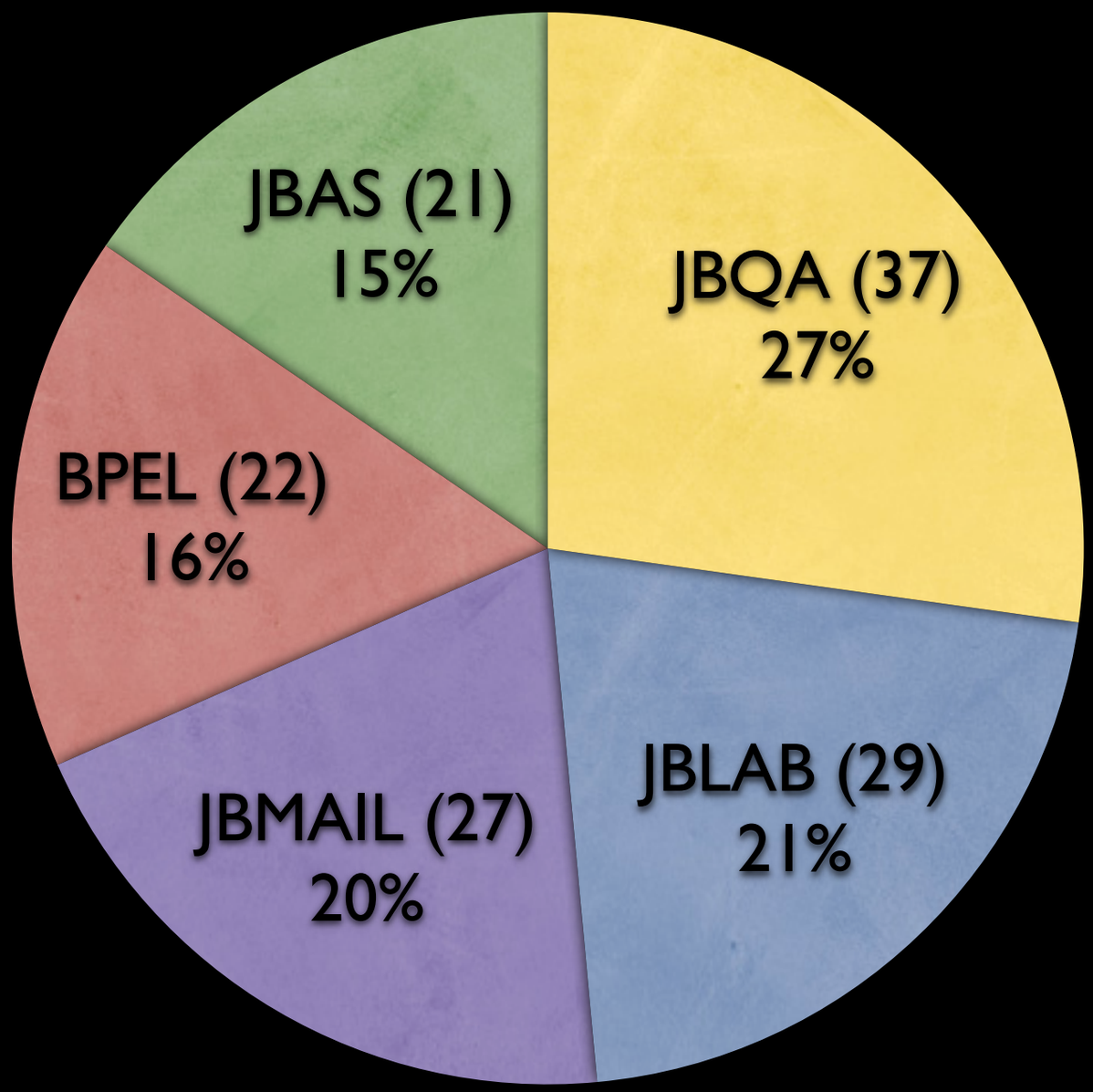
Using Expert Estimates

- Sum of Absolute Residuals - 2,211 hours
- Pred (25) - 40%
- Pred (50) - 63%

Weight-based Avg., 1:1 (S:D) weights, *k* = 9

- Sum of Absolute Residuals - 3,291 hours
- Pred (25) - 16%
- Pred (50) - 27%

JBoss Data Set



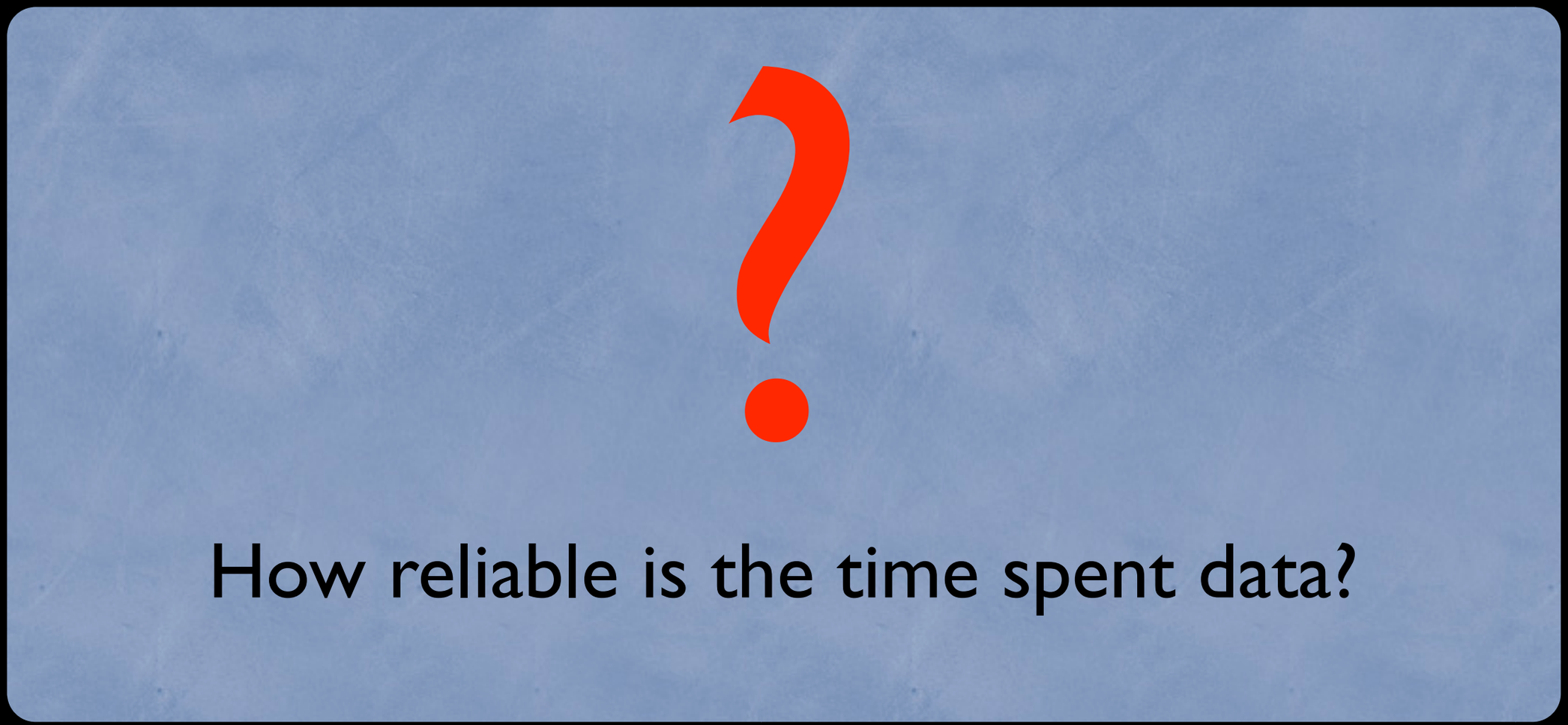
Results from Sub-Projects

	Expert Est.		Prediction	
Project	Pred(25)	Pred(50)	Pred(25)	Pred(50)
JBQA	32%	51%	24%	29%
JBLAB	24%	52%	30%	39%
JBMAIL	56%	78%	31%	38%
BPEL	55%	86%	30%	40%
JBAS	48%	67%	27%	27%

JBoss Data Set

JBoss Data Set

JBoss Data Set



How reliable is the time spent data?

Why may Experts be Better?

Why may Experts be Better?

A boss at JBoss...

Why may Experts be Better?

A boss at JBoss...

"... I would not rely on the data at all."

Why may Experts be Better?

A boss at JBoss...

"... I would not rely on the data at all."

Some JBoss lead developers...

Why may Experts be Better?

A boss at JBoss...

"... I would not rely on the data at all."

Some JBoss lead developers...

"...if the time spent data has been entered, I would consider it fairly reliable."

Other Projects

Other Projects

Eclipse

Other Projects

Eclipse

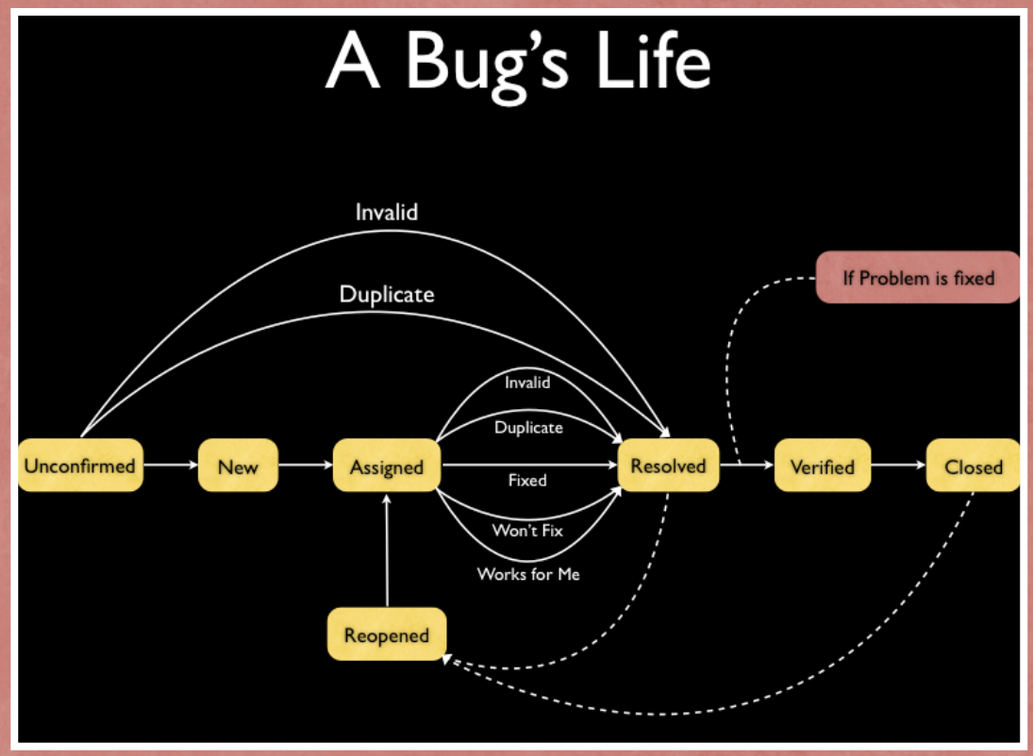
Mozilla

Other Projects

Eclipse

Mozilla

No Effort Data



Predict the lifetime of a bug!

Other Projects

Eclipse

Mozilla

Other Projects

Eclipse

In comparison to using Avg. bug lifetime as predictor, our sum of residuals was lower by 66,387 days for the Eclipse data set.

Mozilla

Other Projects

Eclipse

In comparison to using Avg. bug lifetime as predictor, our sum of residuals was lower by 66,387 days for the Eclipse data set.

Mozilla

For Mozilla, the same is true by 496,526 days.

Conclusions

- It is possible to predict effort at the very moment when a bug is reported.
- Our models performance is more surprising considering only two data points are used.

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- It is possible to predict effort at the very moment when a bug is reported.
- Our models performance is more surprising considering only two data points are used.

In the future, test other prediction techniques and use other useful data in bug reports intelligently.