Automatically Translating Bug Reports into Test Cases for Mobile Apps

Mattia Fazzini  Martin Prammer  Marcelo d’Amorim  Alessandro Orso
Mobile Applications
Mobile Applications
Failures
Bug Reports

Steps to reproduce:
1. Start a new post
2. Type something
3. Tap on the Publish button
4. The app crashes
Goal

Automatically translate descriptions on how to reproduce bugs into test cases
Motivating Example

**Bug Report**

Onko commented on Mar 24, 2017

- Text paragraph
- Logcat information

**Steps to reproduce the behavior**

1. Start a new post
2. Type something
3. Tap on the Publish button
4. The app crashes

- Text paragraph

**WORDPRESS App**

Developer
Motivating Example

Bug Report

Onko commented on Mar 24, 2017

<Text paragraph>
(Logcat information>

Steps to reproduce the behavior

1. Start a new post
2. Type something
3. Tap on the Publish button
4. The app crashes
<Text paragraph>

WORDPRESS App

Developer
Motivating Example

Bug Report

Onko commented on Mar 24, 2017

<Text paragraph>
<Logcat information>

Steps to reproduce the behavior

1. Start a new post
2. Type something
3. Tap on the Publish button
4. The app crashes
<Text paragraph>

WORDPRESS App

Developer
Motivating Example

**Bug Report**

Onko commented on Mar 24, 2017

*<Text paragraph>*

*<Logcat information>*

**Steps to reproduce the behavior**

1. Start a new post
2. Type something
3. Tap on the Publish button
4. The app crashes

*<Text paragraph>*

**WORDPRESS App**

Developer

---

GrboVK9

Content (tap to add text and media)

POST SETTINGS
Motivating Example

**Bug Report**

Onko commented on Mar 24, 2017

*<Text paragraph>*

*<Logcat information>*

**Steps to reproduce the behavior**

1. Start a new post
2. Type something
3. Tap on the Publish button
4. The app crashes

*<Text paragraph>*

**WORDPRESS App**

Developer

```
Unfortunately, WordPress has stopped.
OK
```
Motivating Example

**WordPress App**

**Test Case**

```java
public void test() {
    // start a new post
    onView(
        withId(R.id.fab_button))
        .perform(click());

    // type something
    onView(
        withId(R.id.post_title))
        .perform(typeText("GrbcVK9I"));

    // tap on the publish button
    onView(
        withId(R.id.menu_save_post))
        .perform(click());
}
```
Motivating Example

**WordPress App**

**Test Case**

```java
public void test() {
    // start a new post
    onView(
        withId(R.id.fab_button))
    .perform(click());

    // type something
    onView(
        withId(R.id.post_title))
    .perform(typeText("GrbcVK9I"));

    // tap on the publish button
    onView(
        withId(R.id.menu_save_post))
    .perform(click());
}
```
Motivating Example

**WORDPRESS App**

**Test Case**

```java
public void test() {
    // start a new post
    onView(
        withId(R.id.fab_button))
        .perform(click());

    // type something
    onView(
        withId(R.id.post_title))
        .perform(typeText("GrbcVK9I"));

    // tap on the publish button
    onView(
        withId(R.id.menu_save_post))
        .perform(click());
}
```

**Developer**
Motivating Example

Bug Report

Onko commented on Mar 24, 2017

<Text paragraph>

<Logcat information>

Steps to reproduce the behavior
1. Start a new post
2. Type something
3. Tap on the Publish button
4. The app crashes
<Text paragraph>

Test Case

```java
public void test() {
    //start a new post
    onView(
       (withId(R.id.fab_button))
    .perform(click());

    //type something
    onView(
       (withId(R.id.post_title))
    .perform(typeText("GrbcVK9I"))

    //tap on the publish button
    onView(
       (withId(R.id.menu_save_post))
    .perform(click());
}
```
Yakusu Overview

Ontology Extraction

Bug Report Analysis

UI Actions Search

Test Case

Ontology

Bug Report

Abstract Steps

Test Device

Relevant App
Yakusu Overview

Ontology Extraction

Bug Report Analysis

UI Actions Search

Relevant App

Ontology

Bug Report

Abstract Steps

Test Case
Yakusu Overview

Ontology Extraction

Bug Report Analysis

UI Actions Search

Ontology

Bug Report

Abstract Steps

Test Device

Test Case

Relevant App

UI Actions

Search

Abstract

Steps

Test

Device

Bug Report

Analysis

Ontology

Extraction
Yakusu Overview

1. Relevant App
2. Ontology Extraction
3. Bug Report Analysis
4. UI Actions Search
5. Test Case
Ontology Extraction

Relevant App  Ontology

UI Element Properties

Example

GrbcVK9I
Content (tap to add text and media)
Ontology Extraction

Relevant App  Ontology  UI Element Properties

Example

GrbcVK9I
Content (tap to add text and media)
Ontology Extraction

Relevant App  Ontology  UI Element Properties

Example

GrbcVK9l

Content (tap to add text and media)
Bug Report Analysis

Bug Report  Abstract Steps

Dependency Tree (Case #1)

Example Tap on the Publish button.

Dependency Tree (Case #2)

Example Start a new post.

Abstract Step

'action', 'target', 'properties'

Ontology

word2vec

Clause Vector

Cosine Similarity

Property Vector
Bug Report Analysis

Bug Report → Abstract Steps

Dependency Tree (Case #1)
Example Tap on the Publish button.

Abstract Step
〈action, target, properties〉

Dependency Tree (Case #2)
Example Start a new post.

Ontology

word2vec
Clause Vector
Cosine Similarity
Property Vector
Bug Report Analysis

Bug Report  Abstract Steps

Dependency Tree (Case #1)

Example  Tap on the Publish button.

Abstract Step

<action, target, properties>

Dependency Tree (Case #2)

Example  Start a new post.

Ontology

word2vec

Clause Vector  Property Vector

Cosine Similarity

<?, Start a new post, []>
Bug Report Analysis

Bug Report ➔ Abstract Steps

Dependency Tree (Case #1)

Example: Tap on the Publish button.

Abstract Step

<action, target, properties>

Dependency Tree (Case #2)

Example: Start a new post.

Ontology

word2vec

Clause Vector ➔ Property Vector

Cosine Similarity
UI Actions Search

Abstract Steps → Test Case

Abstract Step: action, target, properties

UI Action: UI action, UI element, properties

Test Device

Relevant App
UI Actions Search

Abstract Steps → Test Case

Abstract Step: {action, target, properties}

UI Action: {UI action, UI element, properties}

Test Device

Relevant App
UI Actions Search

Abstract Step

{Tap, Publish, []}

Find UI Element

word2vec

Publish

UI Elements

Publish

UI element #2

...

UI element #N

Current Execution

{Tap, Publish, []}

Forked Executions

{Tap, UI element #2, []}

...

{Tap, UI element #N, []}

Random UI Action Generation
UI Actions Search

Abstract Step

\[
\langle \text{Tap} , \text{Publish} , \text{[ ]} \rangle
\]

Find UI Element

word2vec

Publish \rightarrow \text{UI Elements}

UI element #2

UI element #N

Current Execution

\[
\langle \text{Tap} , \text{Publish} , \text{[ ]} \rangle
\]

Forked Executions

\[
\langle \text{Tap} , \text{UI element #2} , \text{[ ]} \rangle
\]

\[
\langle \text{Tap} , \text{UI element #N} , \text{[ ]} \rangle
\]

Random UI Action Generation
UI Actions Search

Abstract Step

Find UI Element

word2vec

Publish

UI Elements

Publish

UI element #2

...

UI element #N

Current Execution

Forked Executions

Random UI Action Generation
UI Actions Search

Abstract Step

{Tap, Publish, []}

Find UI Element

word2vec

Publish → UI Elements

Publish

UI element #2

...

UI element #N

Current Execution

{Tap, Publish, []}

Forked Executions

{Tap, UI element #2, []}

...

{Tap, UI element #N, []}

Random UI Action Generation
public void test() {
    // start a new post
    onView(withId(R.id.fab_button)).perform(click());
    // type something
    onView(withId(R.id.post_title)).perform(typeText("GrbcVK9I"));
    // tap on the publish button
    onView(withId(R.id.menu_save_post)).perform(click());
}
Empirical Evaluation

Research Questions:

RQ1: Can YAKUSU translate bug reports written in natural language into executable test cases?

RQ2: What is the cost of running YAKUSU?
Empirical Evaluation

Research Questions:

**RQ1:** Can YAKUSU translate bug reports written in natural language into executable test cases?

**RQ2:** What is the cost of running YAKUSU?
Empirical Evaluation

Research Questions:

RQ1: Can YAKUSU translate bug reports written in natural language into executable test cases?

RQ2: What is the cost of running YAKUSU?
Benchmarks and Setup
Benchmarks and Setup

Could not Build: x 9
Could not Reproduce Manually: x 29
Available Reports: x 62
Successfully Generated Tests: x 37
Benchmarks and Setup

- GitHub
- Bug Report

Could not Build: x 9
Could not Reproduce Manually: x 29
Available Reports: x 62
Successfully Generated Tests: x 37
Benchmarks and Setup

GitHub → Bug Report

Could not Build

Could not Reproduce Manually

Available Reports

Successfully Generated Tests

x 9

x 29

x 62

x 37
## RQ1

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Actions</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>TACHIYOMI</td>
<td>$A_e$</td>
<td>$A_i$</td>
<td>$A_S$</td>
<td>$A_{Sg}$</td>
<td>$S_g$</td>
<td>$S_p$</td>
<td>$H$</td>
<td>$R$</td>
<td>$T_{C_s}$</td>
<td>$T_{C_a}$</td>
<td>5</td>
</tr>
<tr>
<td>03</td>
<td>TWIDERE</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>05</td>
<td>SIGNAL</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>08</td>
<td>REDReader</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>SILENCE</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>23</td>
<td>K-9 MAIL</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>8</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>25</td>
<td>NEXTCLOUD</td>
<td>1 2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>BUTTERKnife</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>35</td>
<td>ODK COLLECT</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>4</td>
<td>11</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>PIX-ART MESSENGER</td>
<td>3 1</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>8</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>YALP STORE</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>4</td>
<td>11</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>OCRReader</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>8</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>WORDPRESS</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>SIGNAL</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>OPEN EVENT</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>TAGMO</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>ANKI DROID</td>
<td>5</td>
<td>5</td>
<td>-</td>
<td>-</td>
<td>8</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>K-9 MAIL</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>CLUTTR</td>
<td>2</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>NEXTCLOUD</td>
<td>2 1</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>84</td>
<td>K-9 MAIL</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>95</td>
<td>MIPOS X</td>
<td>2 3</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>96</td>
<td>SCREEN RECORDER</td>
<td>3 2</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>97</td>
<td>NEXTCLOUD</td>
<td>1 1</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>99</td>
<td>FLASH CARDS</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ID</td>
<td>Name</td>
<td>Actions</td>
<td>Steps</td>
<td>Search</td>
<td>Tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------</td>
<td>---------</td>
<td>-------</td>
<td>--------</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$A_e$</td>
<td>$A_i$</td>
<td>$AS$</td>
<td>$AS_g$</td>
<td>$S_g$</td>
<td>$S_p$</td>
<td>$H$</td>
<td>$R$</td>
<td>$TC_s$</td>
<td>$TC_a$</td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>TACHIYOMI</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>TWIDERE</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>12</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>SIGNAL</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>REDREADER</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>SILENCE</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>K-9 MAIL</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>8</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>NEXTCLOUD</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>BUTTERK NIFE</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>ODK COLLECT</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>4</td>
<td>11</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>PIX-ART MESSENGER</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>YALP STORE</td>
<td>5</td>
<td>-</td>
<td>4</td>
<td>1</td>
<td>11</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>OCRREADER</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>8</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>WORDPRESS</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>SIGNAL</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>OPEN EVENT</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>TAGMO</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>ANKiDROID</td>
<td>5</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>8</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>K-9 MAIL</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>6</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>CLUTTR</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>NEXTCLOUD</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>84</td>
<td>K-9 MAIL</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>95</td>
<td>MIFOSX</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>96</td>
<td>SCREENRECORDER</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>97</td>
<td>NEXTCLOUD</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>99</td>
<td>FLASHCARDS</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ID</td>
<td>Name</td>
<td>Actions</td>
<td>Steps</td>
<td>Search</td>
<td>Tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------</td>
<td>-----------</td>
<td>---------</td>
<td>---------</td>
<td>-------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$A_e$</td>
<td>$A_i$</td>
<td>$AS$</td>
<td>$AS_g$</td>
<td>$S_g$</td>
<td>$S_p$</td>
<td>$H$</td>
<td>$R$</td>
<td>$TC_s$</td>
<td>$TC_a$</td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>TACHIYOMI</td>
<td>4</td>
<td>1</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>03</td>
<td>TWIDERE</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>12</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>05</td>
<td>SIGNAL</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>08</td>
<td>REDReader</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>SILENCE</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>K-9 Mail</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>8</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>NEXTCLOUD</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>BUTTERKnife</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>ODK Collect</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>4</td>
<td>11</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>PIX-ART MESSENGER</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>YALP STORE</td>
<td>5</td>
<td>-</td>
<td>4</td>
<td>1</td>
<td>11</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>OCRReader</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>8</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>51</td>
<td>WordPress</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>SIGNAL</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>6</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>OPEN EVENT</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>68</td>
<td>TAGMO</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>ANKI DROID</td>
<td>5</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>8</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>73</td>
<td>K-9 Mail</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>6</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>CLUTTR</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>6</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>78</td>
<td>NEXTCLOUD</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>84</td>
<td>K-9 Mail</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>95</td>
<td>MIFOSX</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>96</td>
<td>SCREENRECORDER</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>97</td>
<td>NEXTCLOUD</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>99</td>
<td>FLASHCARDS</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ID</td>
<td>Name</td>
<td>Actions</td>
<td></td>
<td>Steps</td>
<td></td>
<td>Search</td>
<td></td>
<td>Tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>---------------------</td>
<td>---------</td>
<td>----------</td>
<td>----------</td>
<td>----------</td>
<td>-----------</td>
<td>----------</td>
<td>----------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$A_e$</td>
<td>$A_i$</td>
<td>$A_S$</td>
<td>$A_{S_g}$</td>
<td>$S_g$</td>
<td>$S_p$</td>
<td>$H$</td>
<td>$R$</td>
<td>$Tc_s$</td>
<td>$Tc_a$</td>
<td></td>
</tr>
<tr>
<td>01</td>
<td>TACHIYOMI</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>03</td>
<td>TWIDERE</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>12</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>05</td>
<td>SIGNAL</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>08</td>
<td>REDReader</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>14</td>
<td>SILENCE</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>23</td>
<td>K-9 MAIL</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>8</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>25</td>
<td>NEXTCLOUD</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>27</td>
<td>BUTTER Knife</td>
<td>1</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>35</td>
<td>ODK Collect</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>4</td>
<td>11</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>39</td>
<td>PIX-ART MESSENGER</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>40</td>
<td>YALP STORE</td>
<td>5</td>
<td>-</td>
<td>4</td>
<td>1</td>
<td>11</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>50</td>
<td>OCRReader</td>
<td>3</td>
<td>-</td>
<td>3</td>
<td>-</td>
<td>8</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>51</td>
<td>WORDPRESS</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>52</td>
<td>SIGNAL</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>57</td>
<td>OPEN EVENT</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>68</td>
<td>TAGMO</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>69</td>
<td>ANKI DROID</td>
<td>5</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>8</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>73</td>
<td>K-9 MAIL</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>6</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>74</td>
<td>CLUTTR</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>6</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>78</td>
<td>NEXTCLOUD</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>84</td>
<td>K-9 MAIL</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>95</td>
<td>MIFOSX</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>96</td>
<td>SCREENRECORDEr</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>97</td>
<td>NEXTCLOUD</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>99</td>
<td>FLASH CARDS</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>6</td>
<td>2</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>-</td>
</tr>
</tbody>
</table>
RQ1

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Actions</th>
<th>Steps</th>
<th>Search</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(A_e)</td>
<td>(A_i)</td>
<td>(AS)</td>
<td>(AS_g)</td>
</tr>
<tr>
<td>01</td>
<td>TACHIYOMI</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>03</td>
<td>TWIDERE</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>78</td>
<td>NEXTCLOUD</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>84</td>
<td>K-9 MAIL</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>95</td>
<td>MIFOSX</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>96</td>
<td>SCREENRECORIDER</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>97</td>
<td>NEXTCLOUD</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>99</td>
<td>FLASHCARDS</td>
<td>3</td>
<td>-</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

9 bug reports had at least one implicit action
7 bug reports had at least one step without explicit action
19 bug reports reproduced exploring only one execution
6 bug reports reproduced exploring more than one execution
4 test cases with additional actions
**RQ1**

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Actions</th>
<th>Steps</th>
<th>Search</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$A_e$</td>
<td>$A_i$</td>
<td>$AS$</td>
<td>$AS_g$</td>
</tr>
<tr>
<td>01</td>
<td>TACHIYOMI</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>03</td>
<td>TWIDERE</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

9 bug reports had at least one implicit action

7 bug reports had at least one step without explicit action

19 bug reports reproduced exploring only one execution

6 bug reports reproduced exploring more than one execution

4 test cases with additional actions
<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Actions</th>
<th>Steps</th>
<th>Search</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$A_e$</td>
<td>$A_i$</td>
<td>$AS$</td>
<td>$AS_g$</td>
</tr>
<tr>
<td>01</td>
<td>TACHIYOMI</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>03</td>
<td>TWIDERE</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

9 bug reports had at least one implicit action

7 bug reports had at least one step without explicit action

19 bug reports reproduced exploring only one execution

6 bug reports reproduced exploring more than one execution

4 test cases with additional actions
<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Actions</th>
<th>Steps</th>
<th>Search</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$A_e$</td>
<td>$A_i$</td>
<td>$AS$</td>
<td>$AS_g$</td>
</tr>
<tr>
<td>01</td>
<td>TACHIYOMI</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>03</td>
<td>TWIDERE</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

9 bug reports had at least one implicit action

7 bug reports had at least one step without explicit action

19 bug reports reproduced exploring only one execution

6 bug reports reproduced exploring more than one execution

4 test cases with additional actions
### RQ1

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Actions</th>
<th>Steps</th>
<th>Search</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$A_e$</td>
<td>$A_i$</td>
<td>$AS$</td>
<td>$AS_g$</td>
</tr>
<tr>
<td>01</td>
<td>TACHIYOMI</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>03</td>
<td>TWIDERE</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>-</td>
</tr>
</tbody>
</table>

9 bug reports had at least one implicit action

7 bug reports had at least one step without explicit action

19 bug reports reproduced exploring only one execution

6 bug reports reproduced exploring more than one execution

4 test cases with additional actions
### RQ1

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Actions</th>
<th>Steps</th>
<th>Search</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$A_e$</td>
<td>$A_i$</td>
<td>$S_g$</td>
<td>$S_p$</td>
</tr>
<tr>
<td>01</td>
<td>TACHIYOMI</td>
<td>4</td>
<td>1</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>03</td>
<td>TWIDERE</td>
<td>2</td>
<td>-</td>
<td>2</td>
<td>12</td>
</tr>
</tbody>
</table>

9 bug reports had at least one implicit action

7 bug reports had at least one step without explicit action

19 bug reports reproduced exploring only one execution

6 bug reports reproduced exploring more than one execution

4 test cases with additional actions

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Steps</th>
<th>Search</th>
<th>Tests</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$AS$</td>
<td>$AS_g$</td>
<td>$TCs$</td>
</tr>
<tr>
<td>78</td>
<td>NEXTCLOUD</td>
<td>2</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>84</td>
<td>K-9 MAIL</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>95</td>
<td>MIFOSX</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>96</td>
<td>SCREENRECORDEER</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>97</td>
<td>NEXTCLOUD</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>99</td>
<td>FLASHCARDS</td>
<td>3</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>
**RQ1:** Can YAKUSU translate bug reports written in natural language into executable test cases?

We consider the results encouraging as YAKUSU is already able to generate test cases for a good number of bug reports.
Future Work

- Extend ontology
- Learn macro-step associated with the app
- Interpret non-crashing failures from bug reports
- Generate test cases from written/spoken test specifications
- Identify duplicate bug reports
Future Work

- Extend ontology
- Learn macro-step associated with the app
- Interpret non-crashing failures from bug reports
- Generate test cases from written/spoken test specifications
- Identify duplicate bug reports
Future Work

- Extend ontology
- Learn macro-step associated with the app
- Interpret non-crashing failures from bug reports
- Generate test cases from written/spoken test specifications
- Identify duplicate bug reports
Future Work

- Extend ontology
- Learn macro-step associated with the app
- Interpret non-crashing failures from bug reports
- Generate test cases from written/spoken test specifications
- Identify duplicate bug reports
Future Work

- Extend ontology
- Learn macro-step associated with the app
- Interpret non-crashing failures from bug reports
- Generate test cases from written/spoken test specifications
- Identify duplicate bug reports
Future Work

- Extend ontology
- Learn macro-step associated with the app
- Interpret non-crashing failures from bug reports
- Generate test cases from written/spoken test specifications
- Identify duplicate bug reports
Summary

Bug Reports

Yakusu Overview

Empirical Evaluation

Future Work

Research Questions:

RQ1: Can Yakusu translate bug reports written in natural language into executable test cases?

RQ2: What is the cost of running YAKUSU?
Summary

Bug Reports

Yakusu Overview

Empirical Evaluation

Research Questions:

- RQ1: Can Yakusu translate bug reports written in natural language into executable test cases?
- RQ2: What is the cost of running Yakusu?

Future Work

- Extend ontology
- Learn macro-step associated with the app
- Interpret non-crashing failures from bug reports
- Generate test cases from written/spoken test specifications
- Identify duplicate bug reports
Summary

Empirical Evaluation

Research Questions:

RQ1: Can Yakusu translate bug reports written in natural language into executable test cases?

RQ2: What is the cost of running Yakusu?

Future Work

- Extend ontology
- Learn macro-step associated with the app
- Interpret non-crashing failures from bug reports
- Generate test cases from written/spoken test specifications
- Identify duplicate bug reports
Summary

Bug Reports

Yakusu Overview

Empirical Evaluation

Research Questions:

RQ1: Can Yakusu translate bug reports written in natural language into executable test cases?

RQ2: What is the cost of running Yakusu?

Future Work

- Extend ontology
- Learn macro-step associated with the app
- Interpret non-crashing failures from bug reports
- Generate test cases from written/spoken test specifications
- Identify duplicate bug reports
Summary

Bug Reports

Yakusu Overview

Ontology Extraction → Bug Report Analysis → UI Actions Search

Empirical Evaluation

Research Questions:
- RQ1: Can Yakusu translate bug reports written in natural language into executable test cases?
- RQ2: What is the cost of running Yakusu?

Future Work

- Extend ontology
- Learn macro-step associated with the app
- Interpret non-crashing failures from bug reports
- Generate test cases from written/spoken test specifications
- Identify duplicate bug reports