

Please note that this survey requires at least a 13" monitor and cannot be completed on a mobile phone.

Consent Form

By completing this online questionnaire (i.e., clicking “Next”), you agree to participate in the study.

The study focuses on investigating the type and amount of information needed for debugging program failures. The study is structured in the form of an online questionnaire with 12 questions, which are split into three parts. Each part includes questions about the same piece of code. The entire survey is expected to take around 20-30 minutes of your time.

As a “thank you”, we will randomly select 10 participants who finished the study to receive a **\$30 Amazon gift card**. Moreover, your participation in this study will help the academic and industrial community gain valuable insight into debugging approaches. The results will be fully anonymized and will be reported in an academic paper, which will be openly available to the community.

Participation is completely voluntary and you may withdraw from the study at any time before the final reports are made public.

We do not collect identifying information in this study. However, **if you would like to be considered for the award, withdraw your data from the study at a later stage, and/or be notified when the results of the study are available, you should provide your email address as contact information.** We will also appreciate it if you provide optional demographic information, which will only be shared in an aggregated form and will not be associated with any individual responses.

Thank you in advance for your time.

Your email address (optional):

Experience and Demographics

1. Which of the following describes you the best? (pick all that apply)

- ☐ Software developer or engineer working in industry
- ☐ Software tester working in industry
- ☐ Researcher working in industry (Research Staff Member, Research Fellow, Research Engineer)
- ☐ Researcher working in academia, non-student (Postdoctoral Fellow, Faculty Member)
- ☐ PhD student
- ☐ Master's student
- ☐ Undergraduate student
- ☐ Other

2. How many years of programming experience while in **school/university** do you have? (in any programming language)

- ☐ No experience
- ☐ Less than 1 year
- ☐ At least 1 but less than 3 years
- ☐ At least 3 but less than 5 years
- ☐ At least 5 but less than 10 years
- ☐ More than 10 years

3. How many years of programming experience **outside of school/university** do you have?

- ☐ No experience
- ☐ Less than 1 year
- ☐ At least 1 but less than 3 years
- ☐ At least 3 but less than 5 years
- ☐ At least 5 but less than 10 years
- ☐ More than 10 years

4. How would you rate your programming skill level?

- ☐ Novice: developed a few small programs
- ☐ Intermediate: developed a few large programs
- ☐ Advanced: developed several large software systems

5. What is your software development area? (e.g., web developer, full stack developer, embedded systems developer, ML data analyst)

6. How do you debug your code? (Pick all that apply)

- ☐ I do not debug my code
- ☐ Program logging (e.g., print)
- ☐ Assertions
- ☐ IDE debugger utilities (e.g., breakpoints and stepping)
- ☐ Other

7. What is your country of employment or studies?

8. What is your age?

- ☐ <25
- ☐ 25-34
- ☐ 35-44
- ☐ 45-54

- What is your gender?

- ## Part I

In this part of the survey, you will be given three different views, named A, B, and C. Each view contains two versions of a code snippet: the old version (V1), where an assertion passes, and a new version (V2), where the same assertion fails due to changes made in the code.

- **Completeness:** include all essential information needed to explain and debug the failure.
- **Conciseness:** do not include unnecessary information, unneeded to explain and debug the failure.

The goal is to identify views that are most helpful to explain and debug the failure.

Note: Clicking on the picture below opens its larger version.

Notations: Lines that correspond to each other in V1 and V2 are given the same line numbers. Numbered empty lines indicate statements that are either excluded in a particular view or are absent in a code version. Specifically, if a line is annotated by "delete", the statement is deleted in a version. Otherwise, it is excluded from the view. Changes between versions ("Add", "Update", "Delete") are shown on arrows between code snippets. For simplicity, each "if" statement (e.g., in line 7) is annotated with a label showing whether the "if" condition is evaluated to true or false. Gray lines indicate statements that are not executed because an "if" statement (e.g., line 7) that evaluates to true prevents their execution. Colored background highlight the differences between the views.

1. Please rank views A, B, and C (1 being the best; 3 being the worst). You can drag the view names into the box and then rank them internally. When ranking views, please consider:

- **Completeness:** include all essential information needed to explain and debug the failure.
- **Conciseness:** do not include unnecessary information, unneeded to explain and debug the failure.

View A

View B

View C

2. Explain your ranking by describing the advantages and disadvantages of each view (given in their sequential order below).

3. Explain the failure in your own words. Specifically, please describe why changes made in this code resulted in the assertion failure.

Part II

Part 2/3: Comparing textual explanations

In this part of the survey, you are given three different **textual** explanations of the failure corresponding to the three code views in the previous part. You will need to rank these explanations based on their:

- **Completeness:** include all essential information needed to explain and debug the failure.
- **Conciseness:** do not include unnecessary information, unneeded to explain and debug the failure.

Note: Clicking on the picture below opens its larger version.

Explanation A

The method convert(src, toType) converts an object src to a specified type toType. The assertion in line 4 checks if the method outputs the same value as the input variable src.

Internally, the method computes and returns the value of the variable result based on its src parameter.
However,
1. In V1, the method first checks if src is not null and is assignable to the target type toType. Since this condition evaluates to true, src is returned directly.
2. In V2, this condition check and the direct return of src have been removed. Instead, a new TokenBuffer is created, and src is serialized into this buffer. The buffer is then used to create a JsonParser, which, combined with a configuration object obtained from the serialization step, is used to deserialize src into result. Finally, the deserialized object is returned.

In summary, removing code that returns the value of the input src variable directly (line 8 in V1) and other returning a computed value (line 14 in V2) causes the returned value in V2 to differ from the value of the input variable src, leading to the assertion failure in line 4.

Explanation B

The method convert(src, toType) converts an object src to a specified type toType. The assertion in line 4 checks if the method outputs the same value as the input variable src.

Internally, the method computes and returns the value of the variable result based on its src parameter.
However,
1. In V1, the method first checks if src is not null and is assignable to the target type toType. Since this condition evaluates to true, src is returned directly.
2. In V2, this condition check and the direct return of src have been removed. Instead, result is computed as a function of src and then returned.

In summary, removing code that returns the value of the input src variable directly (line 8 in V1) and rather returning a computed value (line 14 in V2) causes the returned value in V2 to differ from the value of the input variable src, leading to the assertion failure in line 4.

Explanation C

The method convert(src, toType) converts an object src to a specified type toType. The assertion in line 4 checks if the method outputs the same value as the input variable src.

which is initialized in line 2 to be an instance of TestObject.
The desired conversion type is initialized in line 3 to be TestObject as well.
Internally, the method computes and returns the value of the variable result based on its src parameter.
However,
1. In V1, the method first checks if src is not null and is assignable to the target type toType. Since this condition evaluates to true, src is returned directly.
2. In V2, this condition check and the direct return of src have been removed. Instead, result is computed as a function of src and then returned.

In summary, removing code that returns the value of the input src variable directly (line 8 in V1) and rather returning a computed value (line 14 in V2) causes the returned value in V2 to differ from the value of the input variable src, leading to the assertion failure in line 4.

Notations: Colored backgrounds highlight the differences between the views.

FYI: Views are given below again, for your reference.

View A

V1

```
1 public static void main(String[] args){
2
3     TestObject src = new TestObject();
4     assertSame(src, convert(src, toType));
5 }
6
7 public <T> T convert(object src, Class<T> toType){
8     if (src!=null && isAssignable(src, toType)) {
9         return src;
10     }
11     TokenBuffer buf = new TokenBuffer();
12     Config config = serializeValue(buf, src);
13     JsonParser p = buf.asParser();
14     result = deserialize(p, config);
15     return (T) result;
16 }
```

V2

```
1 public static void main(String[] args){
2
3     TestObject src = new TestObject();
4     assertSame(src, convert(src, toType));
5 }
6
7 public <T> T convert(object src, Class<T> toType){
8     Object result;
9     TokenBuffer buf = new TokenBuffer();
10     Config config = serializeValue(buf, src);
11     JsonParser p = buf.asParser();
12     result = deserialize(p, config);
13     return (T) result;
14 }
```

View B

V1

```
1 public static void main(String[] args){
2
3     TestObject src = new TestObject();
4     assertSame(src, convert(src, toType));
5 }
6
7 public <T> T convert(object src, Class<T> toType){
8     if (src!=null && isAssignable(src, toType)) {
9         return src;
10     }
11     TokenBuffer buf = new TokenBuffer();
12     Config config = serializeValue(buf, src);
13     JsonParser p = buf.asParser();
14     result = deserialize(p, config);
15     return (T) result;
16 }
```

V2

```
1 public static void main(String[] args){
2
3     TestObject src = new TestObject();
4     assertSame(src, convert(src, toType));
5 }
6
7 public <T> T convert(object src, Class<T> toType){
8     Object result;
9     TokenBuffer buf = new TokenBuffer();
10     Config config = serializeValue(buf, src);
11     JsonParser p = buf.asParser();
12     result = deserialize(p, config);
13     return (T) result;
14 }
```

View C

V1

```
1 public static void main(String[] args){
2
3     TestObject src = new TestObject();
4     assertSame(src, convert(src, toType));
5 }
6
7 public <T> T convert(object src, Class<T> toType){
8     if (src!=null && isAssignable(src, toType)) {
9         return src;
10     }
11     TokenBuffer buf = new TokenBuffer();
12     Config config = serializeValue(buf, src);
13     JsonParser p = buf.asParser();
14     result = deserialize(p, config);
15     return (T) result;
16 }
```

V2

```
1 public static void main(String[] args){
2
3     TestObject src = new TestObject();
4     assertSame(src, convert(src, toType));
5 }
6
7 public <T> T convert(object src, Class<T> toType){
8     Object result;
9     TokenBuffer buf = new TokenBuffer();
10     Config config = serializeValue(buf, src);
11     JsonParser p = buf.asParser();
12     result = deserialize(p, config);
13     return (T) result;
14 }
```

4. Please focus on the **textual** explanation now (upper part of the picture). Please rank explanations A, B, and C (1 being the best; 3 being the worst). You can drag the explanation names into the box and then rank them internally.

Items

Explanation A

Explanation B

Explanation C

Ranking Explanations

5. Explain your ranking by describing the advantages and disadvantages of each explanation (given in their sequential order below).

Explanation A:
+
+
-
Explanation B:
+
+
-
Explanation C:
+
+
-
-

6. Which of the following do you prefer to see when understanding and debugging the failure?

- ☐ Code views
- ☐ Textual explanations
- ☐ Both

7. Explain your selection.

Part III

Part 3/3: Analyzing complete code snippets

In this part of the survey, you are given the complete code snippets of versions V1 and V2. You will be asked whether seeing the complete code helps your understanding of the failure.

8. Please select statements you deem important for understanding and debugging the failure (in addition to the changed statements that are clearly important and, thus, already pre-selected below). Click on a statement to select it and click again to deselect it.

V1

1 public static void main(String[] args){
2 TestObject src = new TestObject();
3 Class toType = src.getClass();
4 ✓ assertSame(src, convert(src, toType));
5 }
6 public <T> T convert(object src, Class<T> toType){
7 if (src!=null && isAssignable(src, toType)) {true
8 return src;
9 }
10 Object result;
11 TokenBuffer buf = new TokenBuffer();
12 Config config = serializeValue(buf, src);
13 JsonParser p = buf.asParser();
14 result = deserialize(p, config);
15 return (T) result;
16 }

V2

1 public static void main(String[] args){
2 TestObject src = new TestObject();
3 Class toType = src.getClass();
4 ✗ assertSame(src, convert(src, toType));
5 }
6 public <T> T convert(object src, Class<T> toType){
7
8
9 Object result;
10 TokenBuffer buf = new TokenBuffer();
11 Config config = serializeValue(buf, src);
12 JsonParser p = buf.asParser();
13 result = deserialize(p, config);
14 return (T) result;
15 }

9. Explain your selection.

10. Has seeing the complete code snippet changed your understanding of the failure and why? Would you now augment the explanation you gave in Part 1, Question 3? (you can navigate to your explanation by pressing the back button twice)

11. Please list any suggestions for how the views and textual explanations you liked the most can be improved even further.

12. Do you have any other comments related to this survey?

