Apache Commons Lang Testing (P3)

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Repo URL:https://github.com/chenxu-wang/commons-lang

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Introduce of Structural Testing

Structural testing is also known as “white box” testing. It focuses on the internal state of the object under test and needs to track the operation of the source code. Structural testing design techniques include the following code coverage criteria: (Wikipedia)

1. Statement coverage
2. Branch testing
3. Method-level testing
4. Path testing
5. Control flow testing
6. Data flow testing
7. Decision coverage

Advantages

1. Force testers to think carefully about the implementation process and principles of the software.
2. Every branch and path in the code can be detected.
3. Reveal bugs hidden in the code.
4. Test the code thoroughly.

Description of Existing Test Suite

Tool

The code coverage tool that comes with IntelliJ IDEA is used in this project. It can efficiently calculate class coverage rate, method coverage rate, and line coverage rate.

Existing Test Suite Coverage

Before adding any further test cases. The coverage rate of the existing test suite is as follows:

Overall Coverage Rate

	Class coverage	**Method coverage**	**Line Coverage**
coverage number	290/308	3583/3782	14463/15170
coverage rate	94%	94%	95%

Table 1: Overall coverage rate

Specific Class Coverage Rate

Take StringUtils.java as an example. We subsequently add test cases to it to increase its coverage.

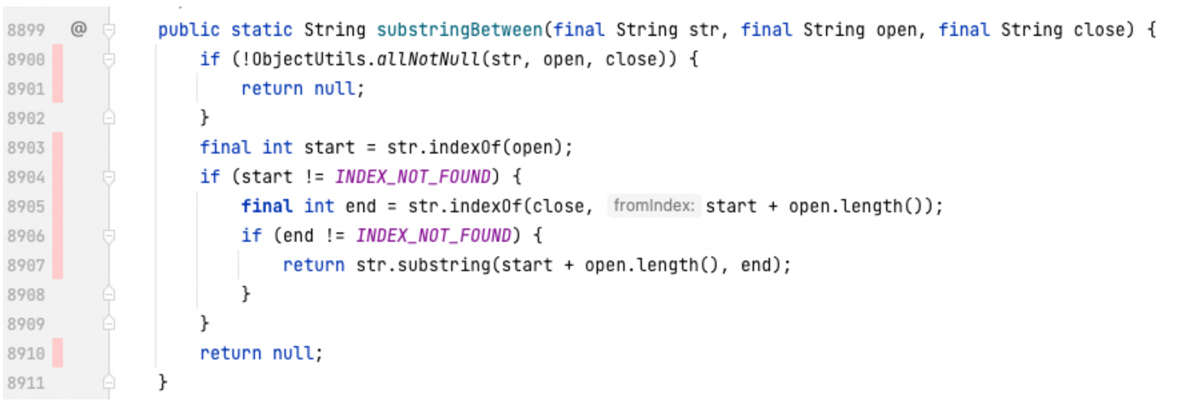
The existing test suite for StringUtils.java is saved in StringUtilsTest.java (Path: org/apache/commons/lang3/StringUtilsTest.java).

	Class coverage	**Method coverage**	**Line Coverage**
coverage number	1/1	174/251	1224/1705
coverage rate	100%	69%	71%

Table2: StringUtils.java coverage rate

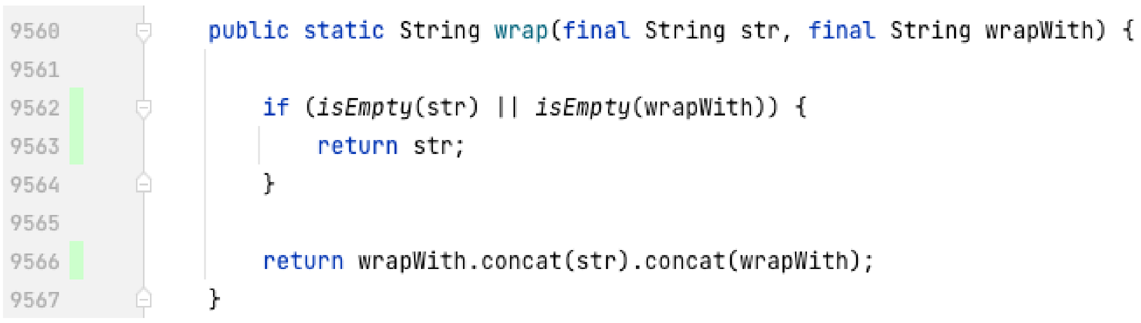
Uncovered Code Example

Uncovered methods and lines are marked in red by using the built-in coverage tool. Those that have already been covered will be marked in green. Examples are shown in Figure1 and Figure2.



```java
public static String substringBetween(final String str, final String open, final String close) {
    if (!ObjectUtils.allNotNull(str, open, close)) {
        return null;
    }
    final int start = str.indexOf(open);
    if (start != INDEX_NOT_FOUND) {
        final int end = str.indexOf(close, fromIndex: start + open.length());
        if (end != INDEX_NOT_FOUND) {
            return str.substring(start + open.length(), end);
        }
    }
    return null;
}
```

Figure1: Uncovered code example



```java
public static String wrap(final String str, final String wrapWith) {

    if (isEmpty(str) || isEmpty(wrapWith)) {
        return str;
    }

    return wrapWith.concat(str).concat(wrapWith);
}
```

Figure 2: Covered code example

New Test Cases

StringUtils.java is chosen as the feature to add coverage testing cases. After adding new test cases its method coverage number increased from 174 to 183, and its line coverage number increased from 1224 to 1299. 75 extra lines of code are covered after modification.

	Class coverage	**Method coverage**	**Line Coverage**
coverage number	1/1	183/251	1299/1705
coverage rate	100%	72%	76%

Table3: StringUtils.java coverage rate after modification

Following are the test cases added in the StringUtilsTest.java:

1. compare() method compares two Strings lexicographically, return int = 0 if str1 is equal to str2 (or both null); return int < 0, if str1 is less than str2, return int > 0, if str1 is greater than str2

```
/**
 * SWE261P3 White box testing for StringUtil
 */

/**
 * Coverage test for int compare(final String str1, final String str2, final boo
lean nullIsLess) at line [867]
 */
@Test
public void testCompare(){
assertEquals(0, StringUtils.compare("abc", "abc", false));
assertEquals(-1, StringUtils.compare(null, "xyz", true));
assertEquals(1, StringUtils.compare(null, "xyz", false));
assertEquals(1, StringUtils.compare("xyz", null, true));
assertEquals(-1, StringUtils.compare("xyz", null, false));
assertEquals(-23, StringUtils.compare("abc", "xyz", false));
assertEquals(-23, StringUtils.compare("abc", "xyz", true));
}
```

2. contains() method checks if CharSequence contains a search CharSequence.

```
/**
 * Coverage test for boolean contains(final CharSequence seq, final CharSequence
searchSeq) at line [996]
 */
@Test
public void testContains(){
assertFalse(StringUtils.contains("abc", null));
assertFalse(StringUtils.contains(null, "abc"));
assertTrue(StringUtils.contains("abc", "a"));
}
```

3. containsAny() method checks if the CharSequence contains any character in the given set of characters.

```
/**
 * Coverage test for containsAny(final CharSequence cs, final char... searchChar
s) at line [1054]
 * need modify
 */

@Test
public void testContainsAny(){
assertFalse(StringUtils.containsAny("xyz", new char[]{}));
assertFalse(StringUtils.containsAny("", new char[]{}));
assertFalse(StringUtils.containsAny("xyz", new char[]{'a','b','c'}));
assertTrue(StringUtils.containsAny("zzabyycdxx", new char[]{'a','z','c'}));
assertTrue(StringUtils.containsAny("zzabyycdxx", new char[]{'b','y'}));
}
```

4. containsWhitespace() method checks whether the given CharSequence contains any whitespace characters.

```
/**
 * Coverage test for boolean containsWhitespace(final CharSequence seq) at line
 [1411]
 */
@Test
public void testContainsWhitespace(){
assertFalse(StringUtils.containsWhitespace(""));
assertFalse(StringUtils.containsWhitespace("abc"));
assertTrue(StringUtils.containsWhitespace("ab c"));
}
```

5. equals() method checks whether two charSequences are equal.

```
/**
 * Coverage test for boolean equals(final CharSequence cs1, final CharSequence c
s2) at line [1801]
 */
@Test
public void testEquals(){
assertTrue(StringUtils.equals(null, null));
assertFalse(StringUtils.equals(null, "abc"));
assertFalse(StringUtils.equals("abc", null));
assertFalse(StringUtils.equals("ab", "abc"));
assertTrue(StringUtils.equals("abc", "abc"));
assertFalse(StringUtils.equals("abc", "ABC"));
assertTrue(StringUtils.equals(" ", " "));
}
```

6. countMatch() method counts how many times the char appears in the given string.

```
/**
 * Coverage test for int countMatches(final CharSequence str, final char ch) and
int countMatches(final CharSequence str, final CharSequence sub) at line 1453 an
d 1489
 */
@Test
public void testCountMatch(){
assertEquals(0,StringUtils.countMatches("",'a'));
assertEquals(2,StringUtils.countMatches("aa",'a'));
assertEquals(0,StringUtils.countMatches("","ab"));
assertEquals(1,StringUtils.countMatches("abc","ab"));

}
```

7. endsWithAny() method checks if a CharSequence ends with any of the provided case-sensitive suffixes.

```
/**
 * Coverage test for boolean endsWithAny(final CharSequence sequence, final Char
Sequence... searchStrings) at line 1739
 */
@Test
public void testEndsWithAny(){
assertEquals(false, StringUtils.endsWithAny("","aa","zzz"));
assertEquals(true, StringUtils.endsWithAny("aaa","a","aa"));
assertEquals(false, StringUtils.endsWithAny("aaa","b","bb"));

}
```

8. indexOfAny() method searches a CharSequence to find the first index of any character in the given set of characters.

```
/**
 * Coverage test for int indexOfAny(final CharSequence cs, final char... searchC
hars) and int indexOfAny(final CharSequence str, final CharSequence... searchStr
s)
 * at line 2759 and 2811
 */
@Test
public void testIndexOfAny(){
assertEquals(-1,StringUtils.indexOfAny("",'a','b'));
assertEquals(0,StringUtils.indexOfAny("abc",'a'));
assertEquals(-1,StringUtils.indexOfAny("abc",'d'));
assertEquals(-1,StringUtils.indexOfAny("","aa","bb"));
assertEquals(-1,StringUtils.indexOfAny("ccc","aa","bb"));
assertEquals(0,StringUtils.indexOfAny("ccc","cc","bb"));
}
```

Reference

Wikipedia, Structural Testing, https://en.wikipedia.org/wiki/Structural_testing