Improve Relevancy of Object Oriented Class Cohesion Metrics with Inheritance

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Abstract - Cohesion is a very important quality attribute in software. As we know that there are number of cohesion metrics are proposed in the literature to measure the cohesion of software systems. These metrics gives undefined values for a large number of classes which comes under special cases. Because of this reason, these metrics became non-applicable for these classes as they are unable to give cohesion values for these classes. In this paper, a value assignment criterion would be used to make cohesion metrics applicable and the concept of inheritance would be included for these special cases. Study the effect of including or excluding the inherited elements i.e., methods and attributes.

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GJCST-C Classification: D.2.3

Strictly as per the compliance and regulations of:
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I. Introduction

Software Engineering is the branch of computer science which is mainly concerned with developing large applications. There are number of quality attributes which are available to measure the quality of softwares i.e., maintainability, reusability, availability, reliability, cohesion, coupling, security, scalability, testability, usability etc.

a) Class Cohesion

Cohesion can be defined as the relatedness of elements in a module. There can be two types of modules in software system:

- Highly Cohesive Module
- Low Cohesive Module

Highly Cohesive Module is defined as those modules whose elements have a tight relationship among themselves. A Low Cohesive Module is defined as the module that has some elements that have little or no cohesion relation to others.

Class consists of following two members:

- Attributes
- Methods

Attributes can be defined as the things where the objects stores the data i.e., variables. On the other hand, Methods can be defined as Functions and Procedures that are attached to an Object and allowing the object to perform the different actions.

II. Related Work

This guideline is used for all journals. These are the manuscript preparation guidelines used as a standard template for all journal submissions. Author must follow these instructions while preparing/modifying these guidelines. This guideline is used for all journals. This guideline is used for all journals. These are the manuscript preparation guidelines used as a standard template for all journal submissions. Author must follow these instructions while preparing/modifying these guidelines. This guideline is used for all journals. This guideline is used for all journals. These are the manuscript preparation guidelines used as a standard template for all journal submissions. Author must follow these instructions while preparing/modifying these guidelines. This guideline is used for all journals. This guideline is used for all journals. These are the manuscript preparation guidelines used as a standard template for all journal submissions. Author must follow these instructions while preparing/modifying these guidelines. This guideline is used for all journals.

In 1998, 2004, 2011, 2012, authors of [1], [2], [6], [7], [8], [9], [10], [11], [12], [13] and [14] excluded all classes that come under special cases mentioned above for which 12 object oriented class cohesion metrics like LCOM1, LCOM2, LCOM5, TCC, LCC, NHD, CC, SCOM, COH, DCD, DCI and CAMC gives undefined cohesion values and cohesion value can never be infinity.
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**a) Review Stage**

In 2011, [3] introduces criteria for assigning cohesion values to classes of special cases, such as classes having lesser than two methods, classes containing no attributes, classes having methods with no parameters. They used a value-assignment criteria to assign values to special cases. But they have not included two factors including inheritance and the accessibility levels i.e., public, protected and private). Through this value-assignment criteria, the applicability of considered metrics in paper increases to 100%.

This paper worked on same criteria as [3] mentioned i.e criteria for assigning cohesion values for special cases, such as classes having lesser than two methods, classes containing no attributes, classes having methods with no parameters and additionally, it will include a factor of inheritance i.e., the inherited attributes and methods would be included.

This paper considered four scenarios:
- both inherited methods and attributes are excluded,
- only inherited attributes are excluded,
- only inherited methods are excluded,
- both inherited methods and attributes are included.

### Table 2.1: The assigned values for the metrics under consideration [3]

<table>
<thead>
<tr>
<th>Metric</th>
<th>m=0 and a&gt;0</th>
<th>m=1 and a=0</th>
<th>m=1 and a&gt;0</th>
<th>m&gt;1 and a=0</th>
</tr>
</thead>
<tbody>
<tr>
<td>NHD</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Coh</td>
<td>1</td>
<td>1</td>
<td>Assigned Before</td>
<td>0</td>
</tr>
<tr>
<td>TCC, LCC, CC, SCOM, CAMC</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>DCD, DCI</td>
<td>1</td>
<td>1</td>
<td>Assigned Before</td>
<td>0</td>
</tr>
<tr>
<td>LCOM1, LCOM2</td>
<td>0</td>
<td>0</td>
<td>Assigned Before</td>
<td>0</td>
</tr>
<tr>
<td>LCOM5</td>
<td>0</td>
<td>0</td>
<td>2*(1-α/a), where α is the summation of the number of distinct attributes accessed by each method in a class.</td>
<td>m/(m-1)</td>
</tr>
</tbody>
</table>

In the table 2.1 m refers to method, a refers to attribute and assigned before means the metric does not show undefined value for the case shown in respective column.

**b) Final Stage**

This paper proposed a tool named SoftMetric Tool to show the comparisons and results of four scenarios using Netbeans IDE 7.3. Java is a high-level programming language originally developed by Sun Microsystems and released in 1995 [4]. Netbeans is a Java IDE that is open source and free. Most developers recognize the NetBeans IDE as the original free Java IDE [5].

i. **SoftMetric**

SoftMetric Tool is implemented using Netbeans. This tool will calculate the cohesion values for the following 12 metrics:
- TCC (Tight Class Cohesion)
- LCC (Loose Class Cohesion)
- NHD (Normalized Hamming Distance)
- CC (Class Cohesion)
- SCOM (Class Cohesion Metric)
- LCOM1 (Lack of Cohesion 1)
- LCOM2 (Lack of Cohesion 2)
- LCOM5 (Lack of Cohesion 5)
Following we take an example of class named test1.class to show the calculation of cohesion using this tool:

1. This following snapshot shows “Select Input File”, this will browse and select .class file. After selecting a class file, we will select one option from four options:
   - exclude all,
   - exclude method,
   - exclude variable
   - include all.

   Exclude All will exclude all inherited members of a class in cohesion calculation, Exclude Method will exclude inherited methods in cohesion calculation, Exclude Variable will exclude inherited methods in cohesion calculation, and Include All will include all inherited members of a class in cohesion calculation. This tool will calculate cohesion for normal classes as well as for special classes also.

   But in this paper, we have just included the result only for special classes like classes those have less than two methods, classes that do not contain attributes, classes whose methods have no parameters.

2. The following snapshot shows the cohesion values of class test1 using 12 metrics calculated for the scenario in which both inherited methods and attributes are excluded.

3. The following snapshot shows the cohesion values of class test1 using 12 metrics calculated for the scenario in which inherited methods are excluded.

4. The following snapshot shows the cohesion values of class test1 using 12 metrics calculated for the scenario in which inherited attributes are excluded.
5. The following snapshot shows the cohesion values of class test1 using 12 metrics calculated for the scenario in which both inherited methods and attributes are included.

6. The following snapshot shows comparison of four scenarios, which shows that with including inherited members increase the overall cohesion of a class i.e., with including inherited member improve the applicability of maximum metrics of the literature.

   ii. Results

   We have considered 55 classes of special cases and calculated cohesion for classes using each
The above chart shows that with including inherited methods and attributes, the cohesion results are better. In it, $m$ refers to methods, $a$ refers to attributes, and $p$ refers to parameters. These results show that including the inherited members increases the cohesion of a class, thus improving the applicability of cohesion metrics by using assigned values for special cases in all four scenarios. Increase the cohesion of maximum number of classes.

III. Conclusion

As there are number of metrics that show undefined values for classes of special cases. This paper proposed a tool for cohesion calculation and studied four scenarios (1) both inherited methods and attributes are excluded, (2) only inherited attributes are excluded, (3) only inherited methods are excluded, and (4) both inherited methods and attributes are included. After studying these scenarios, we get the results that relevancy of maximum of metrics increases with including the inherited metrics.

References Références Referencias

5. https://netbeans.org/about/