PA2559 – Software Metrics
Project (4 hp)

Published: April 21, 2023   **Due date: May 31, 2023**

Goals of this group project:

- Experience applying the GQM measurement framework
- Experience planning and conducting an empirical investigation
- Experience selecting, using and presenting relevant metrics to evaluate a software quality attribute of a real project
- Working as a team (3-4 members) on a project.
  - **Same team from Assignment 1**

Product

The product selected for the course project is JabRef, which is an open-source bibliographic reference manager developed in Java. The information (features and link to Github repository) is available at the following URL:

http://www.JabRef.org/

https://github.com/JabRef/jabref/tags

Project Description

Context: Your team is interested in extending JabRef to further improve its features and quality. However, before starting to extend it, your team decided to systematically evaluate the maintainability of JabRef using a GQM based empirical study.

The team lead wants to allocate more skilled and experienced developers to those JabRef modules *(Please note that in this study module = java package)* and classes that are more difficult to maintain. Therefore, the goal of the study is *to identify the modules that would be more difficult to maintain*. The team identified the following internal attributes as relevant to this goal:

- Code structure
  - Code cohesion
  - Code coupling
- Code complexity
- Code understandability
- Code size

Since your team has already performed a review (Assignment 1) on Object Oriented (OO) code metrics and tools, it is expected that you are able to select suitable OO metrics and tools to perform this study.

Several releases of JabRef are available on Github (along with the tags listing all major versions). To better understand and evaluate JabRef code quality, your team decided to multiple stable/major releases. The selected releases are as follows: 5.1, 5.3, 5.5, 5.7, and 5.9. This will allow you to see whether code quality of JabRef modules improved during that time span? You will be able to see how various code properties (e.g., metrics related to size, structure, complexity etc.) have been evolving over a period of time for different modules.

What needs to be done?

A. Develop a Goal-Question-Metric (GQM) tree corresponding to the defined goal.
   a. Formulate relevant <u>answerable</u> questions to ensure coverage of all the internal attributes described as relevant above.
   b. For each question, what are the metrics you need to measure? Briefly describe the selected metrics, and more importantly <u>provide justifications</u> for selecting specific metrics. You should select <u>multiple metrics for each question</u> so that you have more than one data point to answer each question.
   c. For each selected metric, you need to specify and explain their corresponding scale types.
B. Select and use appropriate tool (s) (using your knowledge from Assignment 1) to collect relevant metrics data from the source code of the product. You need to provide a clear justification for selecting specific tool (s). You can use more than one tool to collect and combine different metrics in your study.
C. Explain how the tool (s) generates various metrics. You should also explain at what level (method and/or class and/or package) the metrics are generated? Java code is organized into packages and classes. Therefore, you need to have the metrics at the package level. If the tool is providing the metrics only at the class level, then you need to explain how you aggregated these at the package level.
D. Use the collected data to answer your questions and then the overall goal. It is important to note that the goal is not to simply extract and print metrics data. We are more interested in what is behind these metrics - How can we use them to answer the questions and achieve the goal of the study.
E. Use suitable analysis/visualization and statistical techniques: Use your knowledge and observations from Assignment 1 and the discussion in Lecture 4 to select appropriate analysis techniques to analyse/visualize metrics data in a meaningful way.
F. This project is an empirical study. As a first step, you have to select a suitable study type for planning and executing this project, and also provide a clear justification for selecting a specific study type. In addition, describe what methods/techniques you used for collecting and analysing the data.

Project deliverables

There are two mandatory deliverables related to the project – both need to be submitted to get a passing grade on the project.

1. Complete GQM tree – which is due on <u>May 4th</u>. This deliverable is an important input for the first mandatory project meeting. You will be required to upload it on Canvas latest by May 4th. You will have the option to revise the GQM tree based on the feedback received during the project meeting. Use the GQM template that we used during the group work on April 6 to develop the tree.
2. Complete project report (whose structure is explained below) – which is due on <u>May 31, 2023.</u>

Report structure

1. **Introduction (5 marks)**
   1.1. Briefly describe how the OO metrics can be used to assess and evaluate quality of OO code. Refer to some of the papers in Assignment 1.
   1.2. Summary of the remaining parts of the report, focusing on the goal and the main findings from the results section.
2. **Research methodology (5 marks)**
   2.1. Select and justify a suitable study type for this project (see F above)
   2.2. Data collection: It is about B and C above
   2.3. Data analyses: Which analysis/statistical techniques have you used to present the results (see E above for more details)? Also, justify the use of the selected techniques.
3. **GQM tree (see A above) (25 marks)**
4. **Results (40 marks):** In the results section, you should try to answer all questions in your GQM tree. It is important that you try to present results in a clearly understandable way. You can have one more look at the articles that you studied in Assignment 1 to get some ideas.
   4.1. The purpose of this section is to provide an overview of JabRef. First, using the latest release 5.9, give an overview of JabRef modules by describing their names and sizes (in terms of LOC and number of classes). Use appropriate descriptive statistics and plots for describing the JabRef modules (e.g., average size, outliers etc.). For each module, identify the main classes (in terms of size using LOC and number of methods). Furthermore, show how JabRef has evolved in terms of size (LOC, number of packages, and number of classes) over the selected five releases.
   4.2. In this section, attempt to answer all questions of the GQM tree separately (as subsections). Use appropriate analysis techniques for answering the questions. Each question in your GQM tree would have multiple metrics associated with it. Therefore, while answering the questions, you need to combine the results for all metrics associated with the questions.
   4.3. In 4.2 above, the focus is on answering individual questions of the GQM tree. In 4.3, you should try to aggregate results for individual questions to answer the overall goal of the study.
5. **Discussion (15 marks)**
   5.1. Analysis of results: In this section, you are required to further build on the analysis in Section 4.3. Try to explore and investigate potential relationships between different attributes. Is there any connection between the size of JabRef modules and good/bad structure and/or between module size and complexity, and/or module size and understandability? Do frequently changed JabRef modules suffer from bad structure or otherwise etc.). Again, use appropriate analysis techniques to investigate the relationships.
   5.2. Reflections on this project/study
      5.2.1. What did you learn from this project?
      5.2.2. The GQM framework consists of five broad steps (see Lecture 3 – Slide 10). Which of the steps you found more challenging to implement?

5.2.3. What are your views about the group work on April 6? Did that help you to use the GQM framework in some way?

The report will be considered incomplete (and desk rejected with an F grade) if any of the above sections are missing. The minimum passing marks are 60/100, i.e., 60% for the minimum passing grade E. If in any case we find out that any part of your report was copied from another source, without using quotes or the original source, the report will be awarded with an F grade. The case will be forwarded for the disciplinary action.

The **presentation of the report** is one of the important aspects. We have allocated **10 marks** for it. We expect that you would make an effort to **present and describe** study results effectively, using a combination of tables and diagrams/graphs. There is no page restriction. You are, however, required to avoid having redundant information/parts in your report. The references should be described completely and consistently. Furthermore, all tables and diagrams in your report should be referred and discussed in the text as well. You are advised to make a conscious effort to format your report exactly according to the IEEE template for conference proceedings available at the following link:

https://www.ieee.org/conferences/publishing/templates.html

Only the reports prepared in the latex would be acceptable, i.e., do not use the word template. The best and easy way would be to use the Overleaf IEEE template available at the above link. Please submit this project report on or before **May 31, 2023** using a single pdf file, and also include a cover page containing your full names and person numbers.

Mandatory on-campus project meetings

We had a mandatory group work session on April 6 in which all groups developed a GQM tree for a given problem statement. In addition to that, we will have two mandatory project meetings (Please refer to the course schedule and memo for the exact dates of these two mandatory meetings). It is mandatory for all group members to attend these meetings i.e., students failing to attend the meetings **would fail the project**. The idea is to discuss your progress and work division, answer your questions, and provide you with some early feedback and suggestions for successfully completing the project. These meetings will be held on campus and no Zoom link will be provided for them.

Please note that all group members are expected to contribute equally to the project. If during the discussions we note that some members are not as active as they should be, we may ask them to appear in a follow-up meeting with us. In that follow-up meeting, the students will be asked to explain their contributions to the project. Lastly, depending on the discussions, we may decide to award different grades to the members of the same group, i.e., all members in the group may or may not receive the same grade.