**Class Size Software Maintainability**

**Objective**

Effect of class size on software maintainability

**Question**

How does class size effect software maintainability?

**Metrics**

WMC: Measures the sum of complexity of the methods in a class

CBO: Count of the number of classes that are coupled to a particular class

**Criteria**

Analyze programs for the purpose of evaluating the effect of class size on software maintainability with respect to programs that are at least 50K in size, at least 5 years old, and have at least 100 developers.

Projects that are at least 50K in size and have at least a team of 100 developers are large projects that consist of organized code for reusability, extensibility, and maintainability. Large projects tend to have a longer lifecycle; thus, maintainability is a key concern. If the project is at least 5 years old, then it has gone through various maintainability tasks since large projects tend to slow down over time.

**Data Set**

|  |  |  |
| --- | --- | --- |
| **Subject Programs** | **Attributes** | **Description** |
| **MyBatis** | Size: 120450  Developers: 189  Year: 2013  Couples objects with stored procedures  SQL statement using XML descriptor or annotations  1574 classes | MyBatis is a first-class persistence framework with support to custom SQL, stored procedures, and advanced mappings.  Eliminates almost all the java database connectivity code and manual setting of parameters and retrieval of results. |
| **Spring Batch** | Size: 100796  Developers: 145  Year: 2010  Transaction Management  Chunk based processing  2833 classes | Spring Batch is a lightweight, comprehensive batch framework designed to enable the development of robust batch applications vital for the daily operations of enterprise systems.  Provides reusable functions that are essential in processing large volumes of records. |
| **Apache Calcite** | Size: 77869  Developers: 287  Year: 2014  Does not store or process data  Standard functions and aggregate functions  5065 classes | Apache Calcite is a dynamic data management framework.  It contains many of pieces that compromise a typical DBMS but omits some key functions such as storage of data and algorithms to process data. |
| **ANTLR** | Size: 66962  Developers: 274  Year: 2010  Generates a parser that can build parse trees  Generates a listener interface  661 classes | ANTLR is a powerful parser generator for reading, processing, executing, or translating structured text or binary files.  It's widely used to build languages, tools, and frameworks. |
| **Robolectric** | Size: 53028  Developers:198  Year: 2010  Fast and reliable unit tests to Android  Handles inflation of views, resource loading and more.  3508 classes | Robolectric is the industry-standard unit testing framework for Android.  Tests run in a simulated Android environment inside a JVM, without the overhead of an emulator. |

**Tool**

The tool used to obtain CK-Code metrics for Java code by means of static analysis can be obtained from GitHub. The tool is developed by a group of 24 developers using Java and for Java programs. Currently, it contains a large set of metrics, including what is used for this analysis, WMC and CBO. Instructions to run the program are given by the authors in the ReadMe file to learn how to run the tool.

@manual{aniche-ck,

title={Java code metrics calculator (CK)},

author={Maurício Aniche},

year={2015},

note={Available in https://github.com/mauricioaniche/ck/}

}

**Graphs**

**MyBatis**

**WMC**

Chart

Description automatically generated

**CBO**

A picture containing graphical user interface

Description automatically generated

**LOC**

Chart

Description automatically generated with medium confidence

There are 1574 classes in the MyBatis program. When comparing WMC and CBO to the LOC the trend shows that as the size of the class increases the value of both metrics increases.

**Spring Batch**

**WMC**

A picture containing chart

Description automatically generated

**CBO**A picture containing graphical user interface

Description automatically generated

**LOC**

Graphical user interface

Description automatically generated

There are 2833 classes in the Spring Batch program. When comparing WMC and CBO to the LOC the trend shows that as the size of the class increases the value of both metrics increases.

**Apache Calcite** 5065 classes

**WMC**

Chart

Description automatically generated

**CBO**

Graphical user interface, application, table, Excel

Description automatically generated

**LOC**

Chart

Description automatically generated

There are 5065 classes in the Calcite program. When comparing WMC and CBO to the LOC the trend shows that as the size of the class increases the value of both metrics increases. The largest WMC outlier, an SqlOperatorTest class, has a 1021 value with 5805 lines of code.

**ANTLR** 661 classes

**WMC**

Chart

Description automatically generated

**CBO**

Chart

Description automatically generated

**LOC**

Chart

Description automatically generated

There are 661 classes in the ANTLR program. When comparing WMC and CBO to the LOC the trend shows that as the size of the class increases the value of both metrics increases. The largest WMC outlier class has a 280 value with 1372 lines of code.

**Robolectric**

**WMC**

Chart

Description automatically generated

**CBO**

Graphical user interface

Description automatically generated with medium confidence

**LOC**

Chart

Description automatically generated

There are 3508 classes in the Robolectric program. When comparing WMC and CBO to the LOC the trend shows that as the size of the class increases the value of both metrics increases.

**Conclusion**

Large projects usually have large teams working on them and could take years to complete so maintainability plays a bigger role because the software life cycle is long in duration. The metrics Weighted Methods Per Class and Coupling Between Objects were used to analyze programs for the purpose of evaluating the effect of class size on software maintainability. The suggested values for the metrics for optimal use are WMC value less than 50, and CBO value less than 15. When comparing the graphs for every program, each program’s maintainability increases when the values for the metrics increase above the suggested value.

The largest program analyzed is Apache Calcite with 5065 classes, 500 of the classes contain over 1000 lines of code. The smallest program, ANTLR, has 661 classes and contains 100 classes with over 200 lines of code. Both metrics were significantly different to their respective programs when compared to size. Classes with lower size have better maintainability. Good practices to follow for keeping projects maintainable include keeping the architecture simple, being consistent, and aiming for low coupling, and high cohesion.

The results confirm that class size does effect software maintainability.

**References**

@manual{aniche-ck,

title={Java code metrics calculator (CK)},

author={Maurício Aniche},

year={2015},

note={Available in https://github.com/mauricioaniche/ck/}

}

@manual{mybatis-3,

title={MyBatis SQL mapper framework for Java},

author={Eduardo Macarron},

year={2013},

note={Available in https://github.com/mybatis/mybatis-3}

}

@manual{spring-batch,

title={Spring Batch},

author={Mahmoud Ben Hassine},

year={2010},

note={Available in https://github.com/spring-projects/spring-batch}

}

@manual{calcite,

title={Apache Calcite},

author={Julian Hyde},

year={2014},

note={Available in https://github.com/apache/calcite}

}

@manual{antlr4,

title={ANTLR v4},

author={Terence Parr},

year={2010},

note={Available in https://github.com/antlr/antlr4}

}

@manual{robolectric,

title={Robolectric},

author={Christian Williams},

year={2010},

note={Available in https://github.com/robolectric/robolectric}

}

Apache calcite. The foundation for your next high-performance database. (n.d.). Retrieved April

3, 2023, from https://calcite.apache.org/docs/

Begin, C. (n.d.). Mybatis. Retrieved April 3, 2023, from https://mybatis.org/mybatis-3/

Robolectric. (2022, September 6). Retrieved April 3, 2023, from https://robolectric.org/

Spring batch5.0.1. Spring Batch. (n.d.). Retrieved April 3, 2023, from

https://spring.io/projects/spring-batch