Project 1

Aulon Mujaj, Henning Lund-Hanssen, Espen Jones

11th March 2016

1 Requirement 1 - Brief analysis

1.1 Brief description

This program is a simulation of the popular game Minesweeper. In this version of Minesweeper, the player is presented with a map of coordinates with questionmarks. Under each questionmark, there is either a number representing how many mines that are in the vicinity of this particular point on the map, or, a mine. The player is prompted for a set of coordinates, which should correlate to a questionmark on the map that the player does not think has a mine beneath it. The game goes on for as long as the player does not hit a questionmark with a mine beneath. The game ends when the player has identified all of the questionmarks without a mine, or if the player hits a questionmark with a mine.

1.2 Analysis

1.2.1 Defects

This program consists of three files.

- Minesweeper.java - The main class of this program. Calls on the two other parts, MineField and Ranking.
- MineField.java - Represents the map of the minefield
- Ranking.java - Handles the highscores of the players playing this game

1.2.2 Minesweeper.java

This main class on the program has the responsibility for the control flow of the program. When should the minefield be called to make a judgement about whether the game is still going or ended? When should the ranking be upon to calculate the score of the player and show the

highscore? It taks input from the terminal and compares it to certain keywords. If the input from the player does not match the input criteria, the game just prompts for new input.

The testable parts in this class consist of handling the input from the user and that the right action is taken accordingly. For example, if the user gives "top" as input to the program, the ranking class should be called to show the ranking of the players. And if restart is called, you would expect the program to restart your session.

1.2.3 MineField.java

1.2.4 Ranking.java

1.3 Non-functional tests

Non-functional tests should always be tested. Though, this code looks like it was submitted in some introduction course in Java programming. If we look on this as a mandatory assignment in such a course, it should run on every machine at UiO installed with Java. If this were to be a huge game developed by a real company with the goal of making a multiplayer minesweeper with a regional highscore for each country and so on. The amount of non-functional requirements will increase.

We have decided to measure the non-functional requirements to meet what we can extract from the Minesweeper game on Windows 10.

1.3.1 Performance, load and stress

The program should not strain the computer to the point where Minesweeper prevents normal execution of other programs.

1.3.2 Reliability

If the program crashes, it does not save the state, so it is not recoverable after a crash. Though, the original game of Minesweeper does not do this either.

1.3.3 Usability

Playing the game requires the player to have previous knowledge of coordination systems. The instructions on how to play the game is lacking to some degree. It is a single line that instructs the user to give coordinates as input and to not step on a mine. This is forgiving to some degree, as most of us have previous experience with the Minesweeper game.

1.3.4 Efficiency

The program operates instantaneously both when it comes to asking for input and calculating the highscore. Also, the program as a whole does not utilize anything more than it needs to.

1.3.5 Maintainability

If changes is to be made to this system, the programmer has to know the Java programming language. If not, it as to be written from scratch in order for a change to be made. It is not imported or implemented a test library like JUnit for testing the different parts of the program, so it is not easy to just implement new tests without interrupting the data flow of the program.

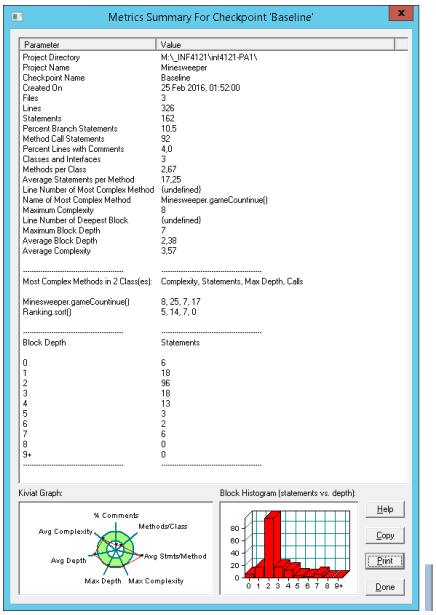
1.3.6 Portability

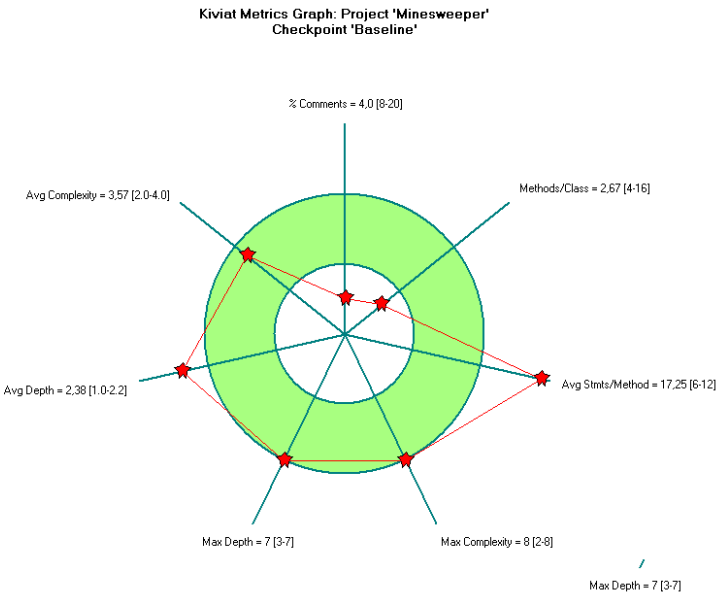
The only requirement for the program to be run is Java. The program can be run automatically with an IDE like IntelliJ or Eclipse. Without an IDE, you have to have some knowledge about the Java Platform. An alternative to just use the Java compiler and platform is to use a software project management system like Maven, Ant or Make. They will shorten and ease up the process of defining goals like compilation, testing and running the system standalone or for example with an application server like Tomcat or Jetty

1.4 Test cases

2 Requirement 2 - In-depth metrics

2.1 Metrics at project level





- What metrics do you spot for the whole project in the window Metrics Summary for Checkpoint? Write a brief description of the metrics. Try to explain their values (below what is expected, as expected or above the expected level). What metrics do you think need to change?

- Which is the biggest file you have in your project by the number of lines of code?
  MineField.java

- Which is the file with most branches in your project?

- Which is the file with most complex code? What metric did you choose to answer to this question?
  Minesweeper.java

Write a little about each metric, maybe we'll only write about the 6 different metrics from the kiviat diagram, instead of each metric from the metric summary image?

If we choose to go only for the metrics from the kiviat diagram, then we'll only need to write about:

Avg complexity, avg depth, max depth, % comments, methods/class, avg stats/method, max complexity

Files: This project that we are testing and analyzing has a total of three files

Lines: There are in total 326 lines of code throughout the three files.
Statements: Statements are terminated with a semicolon character in Java. Those lines of code are not the only ones that are statements, but branches suchs as if, for and while are also counted as statements. At the same time, exception control statemens try, catch and finally are also counted as statements, and throw statements. Our project that we chose has in total 162 statements.

Percent Branch statements: There are multiple statements that are regarded as branch statements. These are; if, else, for do, while, break, continue, switch, case and default, but we also count exception block statements such as try, catch, finally and throw as branch statements. The percent branch statements is how much percent of all the statements are branch statements in our project. This number in our project is 10.5% which means that out of 162 statements, 16 of those are branch statements

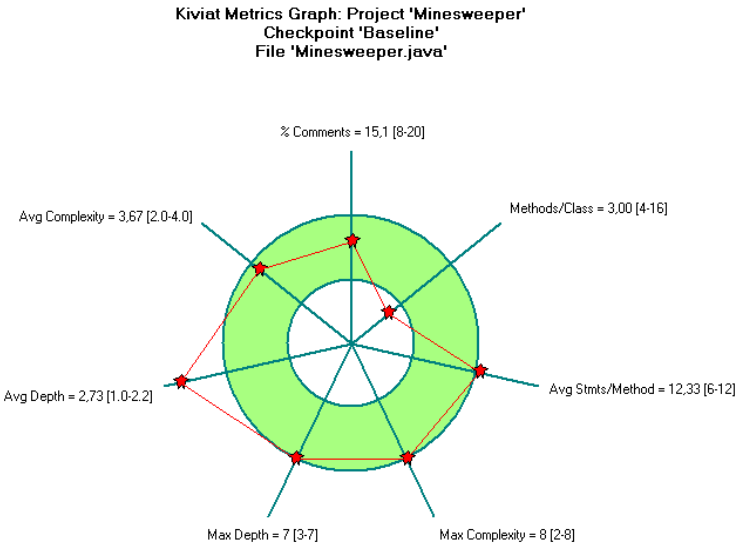
Method call statements: All calls are counted, both in statements and in logical expressions. Our porject has 92 method call statements.

Percent lines with comments: Off all the lines throughout the three files, the percentage that are comments is 4%. Which means that from 326 lines of code, 13 lines are comments. This isn't that much really, but if the code is easy to read and understand, that it does not really matter. If the code is unreadable with obscure variable names and complex logic, then it needs more comments.

Classes and Interfaces: SourceMonitor checks for the name "class <class name>" or "interface <interface name>" and extracts the class names. Both interfaces and classes are counted together. Our project has only three classes and no interfaces.

Methods per class: Average Statements per Method: Name of Most complex methods Maximum Complexity Maximum Block Depth Average Block Depth Average Complexity Most complext methods (complexity, statements, max depth, calls) How many statements on each block depth

2.2 Metrics at file level



- How do you interpret the metrics applied on your file? How are they different the metrics you optained on the whole project, compared with the metrics ont his file?

- Would you refactor (re-write) any of the methods you have in this file?

3 Requirement 3 - Code improvement

3.1 Identification of metrics

For the file Minesweeper.java the two metrics that are outside of ... are 'Method/class' and 'Avg. Depth'. These two metrics are pretty good correlation. By moving code in nested if-statements or that in some way have a high depth into methods, this will give less 'Avg. depth' and more Methods per Class. But this also correlates to 'Avg.Complexity' and 'Avg. Statements per method'. By creating a lot of methods that does only a small amount, meaning they have low complexity and low number of statements, these two metrics would be lowered,

The code is not really documented either, but includes code disabled by being commented out. This metrics looks fine, but after removing the disabled code, no comments remain.

3.2 Changes: Minesweeper.java

First of the file Minesweeper.java has a lot of unnecessary indentations, which give higher average depth for no use. For example this part:

```
if (field.legalMoveString(input)) {
        result++;
        if (result == 35) {
                System.out.println("Congratulations you WON the game!");
                {
                        rank.recordName(result);
                        {
                                return true;
                        }
                }
        }
        continue;
}
```

Here we have two completely redundant indentations. Both 'rank.recordName(result) and 'return true;', have no reason to be indented, and would yield the same result by being at the same depth as the print-line.

A second code bit for improvement is the 'gameContinue()' method. This part does a lot of work on depth four, and much of the work would be natural to insert into sub-methods, granting cleaner code and more in-line with the kiviat metrics. I chose to create a separate method for checking input, called from gameContinue(), in addition all game action calls on methods to do the work, instead of doing the work at the level four depth.

To avoid lowering the 'Statements per method' and avg. Complexity, I've combined methods for similar functions. The 'restart', 'exit' in addition to trigger for game lost and game won does more or less the same, so it's clearly a good practice to gather these code executions into one method like this:

```
public static int endRound(int result, int code) {
        if(code == GAME_LOST) {
                System.out.println("\nBooooooooooooooooooooooooooooom!You stepped on
        } else if (code == GAME_WON) {
                System.out.println("Congratulations you WON the game!");
        }
        rank.recordName(result);
        return code;
}
```

I also changed some of the logic in the code, making it easier to split code into methods. gameContinue() is no longer a boolean, but an int and return codes based on the reason for game end or game game status. The 'gameContiue()' method will return the code from checkInput unless the code is GAME_CONTINUE.

```
static final int GAME_EXIT = 1;
```

```
static final int GAME_CONTINUE = 2;
static final int GAME_RESTART = 3;
static final int GAME_LOST = 4;
static final int GAME_WON = 5;

/* Check the input from user, and call correspoing methods */
private static int checkInput(String input, int result) {
        if (input.equals("top")) rank.show();
        else if (input.equals("restart")) {
                return endRound(result, GAME_RESTART);
        }
        else if (input.equals("exit")) {
                return endRound(result, GAME_EXIT);
        }
        else if (field.legalMoveString(input)) {
                return legalMove(result);
        }
        else if (field.getBoom()) {
                return endRound(result, GAME_LOST);
        }
        return GAME_CONTINUE;
}
```

Lastly inserting simple documentation for every method will suffice for keeping the '% comments' inside recommended values.

3.3 Results from changes

Figure 2 Shows that the kiviat metrics are all inside recommended values. The intention was as mentioned to up Methods per class, and decrease the average depth, while keeping the rest inside recommended metrics. All metrics have been altered by the changed, but by the though process of the improvement all metric are inside recommended values. The most notable change from figure 1 is the max depth, which is plainly is the removal of the redundant indentations. Also the avg complexity and avg statements. per method has been lowered in affect to the introduced 'helper' methods.

3.4 Final remarks

Figure 1: Kiviat graph of Minesweeper.java before changes

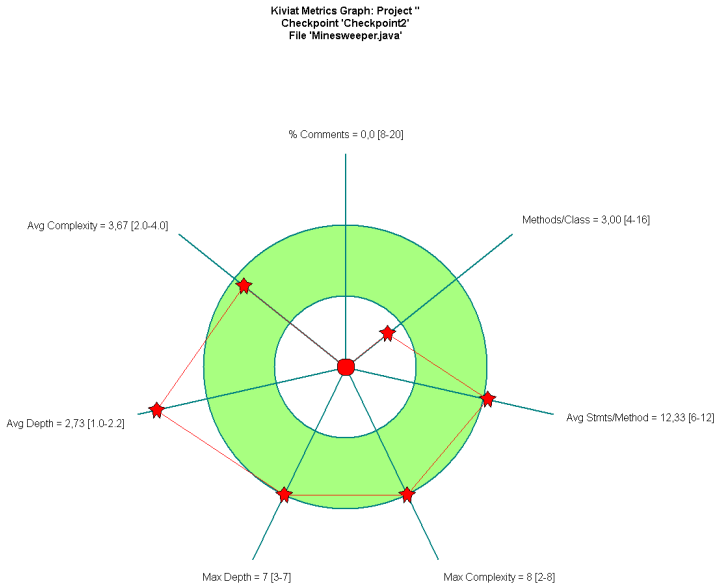


Figure 2: Kiviat graph of Minesweeper.java after changes