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Week 7: Refactoring

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Task 1:

Size:

1. Total LOC for the project (java.memoranda) is 2190
2. Largest code file in the project is EventsManager.java with 329 LOC.
3. It is using the basic SLOC method. It ignored white space and counted everything else (including comments and curly braces). It is not counting using logical lines of code.

Cohesion:

1. LCOM2 uses the Henderson-Sellers method. The LCOM2 stands for Lack of Cohesion Among Method of Class, which measures the extent of intersections of individual method parameter types lists with the parameter type list of all methods in the class. $LCOM2 = 1 - \text{sum}(mA)/(m*a)$

m	<i>number of procedures (methods) in class</i>
a	<i>number of variables (attributes) in class</i>
mA	<i>number of methods that access a variable (attribute)</i>
$\text{sum}(mA)$	<i>sum of mA over attributes of a class</i>

There are several with a mean of zero, so I'll choose one at random and say EventImpl.java. It has the highest as it's mean is zero. More than that however, there are no class level variables, only local variables contained within the methods. I believe this to be the reason why.

Complexity:

1. The cyclomatic complexity of the package is 1.746
2. The class with the worst complexity, on average, would be the EventsManager.java with a mean of 2.5
- 3.) I changed the event manager method getRepeatableEventsForDate() and extracted some of it's contents into a new method. In the new method, which is getRepeatableEventsForDateHelper(), I consolidated all the if checks that resulted in the same action being taken. This reduced the complexity score from 2.5 to 2.394. This reduced complexity as it is a method which contains many if and else if statements, which creates a lot edges. Essentially, it is a method trying to do too much on its own.

Package-level coupling:

1.) The easiest way to describe it would be that Efferent is a measure of the number of classes a class is using from other packages. Afferent would be the opposite as in the numbr of other Classes that use it's class. For example:

```
Class Foo {  
    SomeClass x;  
}  
  
Class SomeOtherFoo {  
    SomeClass y;  
}  
  
Class SomeClass {  
    //..  
}
```

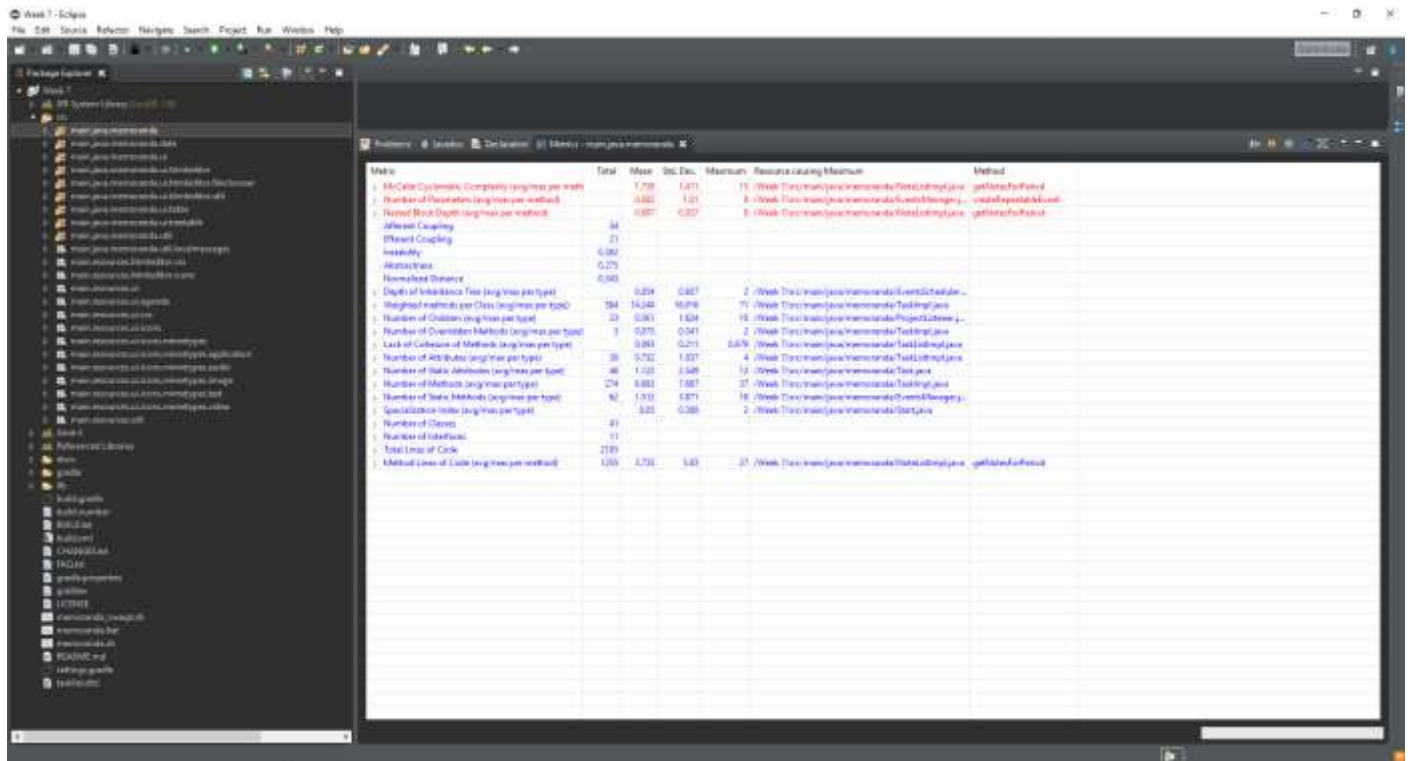
Class Foo and class SomeOtherFoo are efferent as they use an outside class within their class. SomeClass would be considered Afferent as it is being used in other classes.

- 2.) The package with the most afferent coupling would be the main.java.memoranda.util package with a value of 57;
- 3.) The package with the most efferent coupling is the main.java.memoranda.ui package with a value of 49.

Worst Quality

I think the class with the worst quality would be the EventManager.java class. It has a high cyclomatic complexity as well as the highest number of parameters per method. In addition, it has the highest LOC count which makes it one of the more complicated classes in the package. It seems to me this class is doing more work than it likely needs to and that some of it could be broken down and split up. I know there are a lot of conditional statements in there that could be simplified in some way.

Task 2:



Metric	Total	Mean	Std. Dev.	Maximum	Resource Locating Maximum	Method
McClellan Cyclomatic Complexity (degree per method)	1,738	1,071	15	15	15	Week 7\com.java.hello.world\EventManager.java
Number of Parameters (degree per method)	0,881	1,01	8	8	8	Week 7\com.java.hello.world\EventManager.java
Number of Blocks (degree per method)	0,887	0,887	8	8	8	Week 7\com.java.hello.world\EventManager.java
Average Coupling	54					
Effort Coupling	21					
Locality	0,382					
Abstraction	0,275					
Normalized Distance	0,503					
Depth of Inheritance Tree (avg/line per type)	0,059	0,057	2	2	2	Week 7\com.java.hello.world\EventManager.java
Weighted methods per Class (avg/line per type)	154	14,344	6,876	71	71	Week 7\com.java.hello.world\EventManager.java
Number of Classes (avg/line per type)	23	0,261	1,624	16	16	Week 7\com.java.hello.world\EventManager.java
Number of Overridden Methods (avg/line per type)	3	0,075	0,341	2	2	Week 7\com.java.hello.world\EventManager.java
Look of Cohesion of Methods (avg/line per type)	0,883	0,215	0,676	0,676	0,676	Week 7\com.java.hello.world\EventManager.java
Number of Abstract Methods (avg/line per type)	38	0,732	1,037	4	4	Week 7\com.java.hello.world\EventManager.java
Number of Static Abstract Methods (avg/line per type)	46	1,021	1,349	13	13	Week 7\com.java.hello.world\EventManager.java
Number of Methods (avg/line per type)	294	0,883	7,887	37	37	Week 7\com.java.hello.world\EventManager.java
Number of Static Methods (avg/line per type)	82	1,513	1,971	16	16	Week 7\com.java.hello.world\EventManager.java
Specialization Index (avg/line per type)	0,81	0,388	0,2	0,2	0,2	Week 7\com.java.hello.world\EventManager.java
Number of Classes	41					
Number of Interfaces	11					
Total Lines of Code	2189					
Method Lines of Code (avg/line per method)	1,05	0,731	0,43	0,731	0,731	Week 7\com.java.hello.world\EventManager.java

[illegible]

Quite a number of metrics increased for the worse actually. Cyclomatic complexity, number of parameters and nested block depth averages all increased further into the red. For most of these, I believe it is due to the fact that the interfaces had very low scores in these metrics, so while included, they reduced the overall average. With these removed however, I think the values are more where they are supposed to be. This is especially true in the complexity score as each interface had a mean of 1 which impacted the scores rather significantly.

Step 1: Refactored `main.java.memoranda.EventManager.java`. This class was overly large and it contained a number of static classes that dealt with time that I felt could be in their own, outside class. I took out the static classes (Year, Month and Day), and the methods that were used to get their data, and put it into a new class called `TimeData`. This cut down the LOC for `EventManager` quite a bit and helped to decouple some of the workings.

Step 2: I found one code smell between classes where a particular class, `History.java`, was overly visible to the rest of the package. Too many of its internals were open for any other class to call, and none of them have a need for that much access. That said, I went through and modified the internals to be private except for those ones that other classes needed to call. This resulted in a diminished public surface.

The screenshot displays the RStudio environment. The file explorer on the left shows a project named 'RStudio' with a file named 'getRefinedRefined.R'. The script editor in the center contains the following R code:

```
R
getRefinedRefined = function(method, type) {
  # Get the number of methods for each type
  n_methods = length(method)
  n_types = length(type)

  # Create a matrix to store the results
  results = matrix(NA, nrow = n_methods, ncol = n_types)

  # Loop over methods and types
  for (i in 1:n_methods) {
    for (j in 1:n_types) {
      # Calculate the results for each method and type
      results[i, j] = getRefinedRefined(method[i], type[j])
    }
  }

  # Return the results
  results
}

# Example usage
getRefinedRefined("Method1", "Type1")
```

The console at the bottom shows the output of the function, including a table of results for different methods and types.

Method	Type	Value	Std. Dev.	Minimum	Maximum	Mean
Method1	Type1	0.000	0.000	0.000	0.000	0.000
Method2	Type1	0.000	0.000	0.000	0.000	0.000
Method3	Type1	0.000	0.000	0.000	0.000	0.000
Method4	Type1	0.000	0.000	0.000	0.000	0.000
Method5	Type1	0.000	0.000	0.000	0.000	0.000
Method6	Type1	0.000	0.000	0.000	0.000	0.000
Method7	Type1	0.000	0.000	0.000	0.000	0.000
Method8	Type1	0.000	0.000	0.000	0.000	0.000
Method9	Type1	0.000	0.000	0.000	0.000	0.000
Method10	Type1	0.000	0.000	0.000	0.000	0.000
Method11	Type1	0.000	0.000	0.000	0.000	0.000
Method12	Type1	0.000	0.000	0.000	0.000	0.000
Method13	Type1	0.000	0.000	0.000	0.000	0.000
Method14	Type1	0.000	0.000	0.000	0.000	0.000
Method15	Type1	0.000	0.000	0.000	0.000	0.000
Method16	Type1	0.000	0.000	0.000	0.000	0.000
Method17	Type1	0.000	0.000	0.000	0.000	0.000
Method18	Type1	0.000	0.000	0.000	0.000	0.000
Method19	Type1	0.000	0.000	0.000	0.000	0.000
Method20	Type1	0.000	0.000	0.000	0.000	0.000
Method21	Type1	0.000	0.000	0.000	0.000	0.000
Method22	Type1	0.000	0.000	0.000	0.000	0.000
Method23	Type1	0.000	0.000	0.000	0.000	0.000
Method24	Type1	0.000	0.000	0.000	0.000	0.000
Method25	Type1	0.000	0.000	0.000	0.000	0.000
Method26	Type1	0.000	0.000	0.000	0.000	0.000
Method27	Type1	0.000	0.000	0.000	0.000	0.000
Method28	Type1	0.000	0.000	0.000	0.000	0.000
Method29	Type1	0.000	0.000	0.000	0.000	0.000
Method30	Type1	0.000	0.000	0.000	0.000	0.000
Method31	Type1	0.000	0.000	0.000	0.000	0.000
Method32	Type1	0.000	0.000	0.000	0.000	0.000
Method33	Type1	0.000	0.000	0.000	0.000	0.000
Method34	Type1	0.000	0.000	0.000	0.000	0.000
Method35	Type1	0.000	0.000	0.000	0.000	0.000
Method36	Type1	0.000	0.000	0.000	0.000	0.000
Method37	Type1	0.000	0.000	0.000	0.000	0.000
Method38	Type1	0.000	0.000	0.000	0.000	0.000
Method39	Type1	0.000	0.000	0.000	0.000	0.000
Method40	Type1	0.000	0.000	0.000	0.000	0.000
Method41	Type1	0.000	0.000	0.000	0.000	0.000
Method42	Type1	0.000	0.000	0.000	0.000	0.000
Method43	Type1	0.000	0.000	0.000	0.000	0.000
Method44	Type1	0.000	0.000	0.000	0.000	0.000
Method45	Type1	0.000	0.000	0.000	0.000	0.000
Method46	Type1	0.000	0.000	0.000	0.000	0.000
Method47	Type1	0.000	0.000	0.000	0.000	0.000

It would appear that, as a result of the refactoring, a few metrics have actually become worse. One would be the cyclomatic complexity value which changed from 1.738 to 2.016. This could perhaps be a result of extracting some methods from the EventManager class into the TimeData class and having calls between them. The visibility changes to History shouldn't have had an effect on this. It also appears the number of parameters has increased from 0.683 to 0.73. This would be the result of having to add additional parameters to the methods I extracted to TimeData to make them still work with EventManager. Nested depth also increased from 0.997 to 1.377. This too likely due to the changes made to EventManager. A few metrics however did improve. Afferent coupling reduced from 34 to 31. Efferent from 21 to 17. Abstractness also went from 0.275 to zero. All of which, again, would be contributed to the extractions of classes from EventManager into TimeData.