

Software Processes and Product Metrics

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Assignment 1

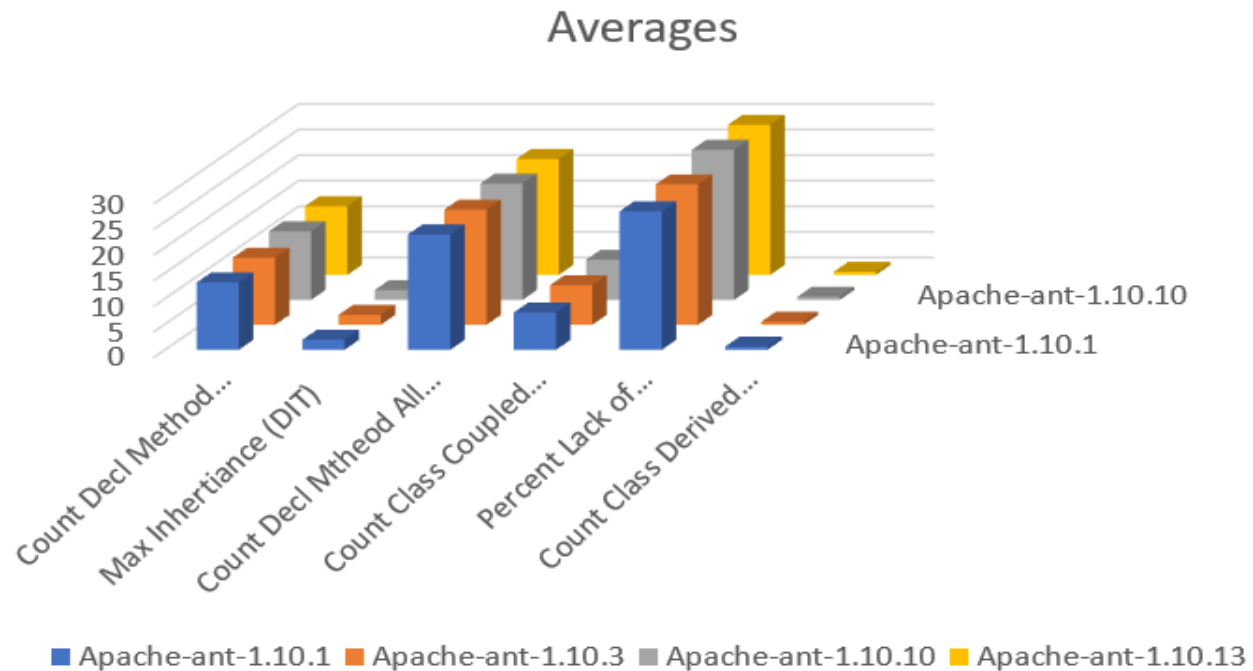
Date :17/04/2023

INTRODUCTION.

In this assignment I used **Apache Ant**. Apache Ant is a Java library and command-line tool whose mission is to drive processes described in build files as targets and extension points dependent upon each other. The main known usage of Ant is the build of Java applications. Ant supplies a number of built-in tasks allowing to compile, assemble, test and run Java applications. The latest version of it is Apache Ant 1.10.13. I did analyse version 1.10.1, 1.10.3, 1.10.10, 1.10.13 The metrics required was extracted as required and saved in a excel file.

The metrics (*Weighted Methods per Class (WMC)*, *Depth of Inheritance Tree (DIT)*, *Number of Children (NOC)*, *Response for a Class (RFC)*, *Coupling Between Objects (CBO)*, *Lack of Cohesion of Methods (LCOM)*) all were analysed in all the versions defined. The averages of the metrics were saved in a different csv file which were again converted to excel files for the graphs to be generated.

The graph of all average metrics used in Apache Ant for all versions 1.10.1, 1.10.3, 1.10.10, 1.10.13:



Metrics analysed in excel files:

Kind	Name	File	Entity_UniqueName	MaxInheritanceTree	CountDeclMethodAll	CountDeclMethod	PercentLackOfCohesion
Package	(Unnamed_Package)Task1.java	@I\Private@k4APrivate@f\src\etc\testcases\taskdefs\optional\depend\src5\A.java	@I\Private@k4APrivate@f\src\etc\testcases\taskdefs\optional\depend\src5\A.java	2	0	12	0
Public Class	A	A.java	@IA@k4A@f\src\etc\testcases\taskdefs\optional\depend\src1\A.java	1	0	0	0
Public Class	A	A.java	@IA@k4A@f\src\etc\testcases\taskdefs\optional\depend\src2\A.java	1	0	0	0
Public Class	A	A.java	@IA@k4A@f\src\etc\testcases\taskdefs\optional\depend\src3\A.java	1	0	0	0
Public Class	A	A.java	@IA@k4A@f\src\etc\testcases\taskdefs\optional\depend\src4\A.java	2	0	0	0
Private Static Class Inner	A	A.java	@IA.Inner@k4A.Inner@f\src\etc\testcases\taskdefs\optional\depend\src2\A.java	1	0	0	0
Private Static Class Inner	A	A.java	@IA.Inner@k4A.Inner@f\src\etc\testcases\taskdefs\optional\depend\src3\A.java	2	0	0	0
Private Static Class Inner	A	A.java	@IA.Inner@k4A.Inner@f\src\etc\testcases\taskdefs\optional\depend\src4\A.java	2	0	0	0
File	A.java	A.java	@I\src\etc\testcases\taskdefs\optional\depend\src1\A.java	1	1	0	0
File	A.java	A.java	@I\src\etc\testcases\taskdefs\optional\depend\src2\A.java	1	1	0	0
File	A.java	A.java	@I\src\etc\testcases\taskdefs\optional\depend\src3\A.java	1	1	0	0
File	A.java	A.java	@I\src\etc\testcases\taskdefs\optional\depend\src4\A.java	2	3	0	0
File	ANTLR.java	ANTLR.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\ANTLR.java	1	0	24	0
File	ANTLRTest.java	ANTLRTest.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\ANTLRTest.java	1	0	18	0
Class	APrivate	A.java	@IAPrivate@k4APrivate@f\src\etc\testcases\taskdefs\optional\depend\src5\A.java	1	0	0	0
File	AbstractAccessTask	AbstractAccessTask.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\unix\AbstractAccessTask.java	2	3	6	0
File	AbstractAnalyzer	AbstractAnalyzer.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\util\AbstractAnalyzer.java	1	0	16	0
File	AbstractClasspathResource	AbstractClasspathResource.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\resources\AbstractClasspathResource.java	1	0	19	0
File	AbstractCvsTask	AbstractCvsTask.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\AbstractCvsTask.java	1	1	47	0
File	AbstractCvsTaskTest	AbstractCvsTaskTest.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\AbstractCvsTaskTest.java	2	1	5	0
File	AbstractFileSet	AbstractFileSet.java	@I\src\main\org\apache\tools\ant\types\resources\AbstractFileSet.java	2	1	70	0
File	AbstractFileSetTest	AbstractFileSetTest.java	@I\src\main\org\apache\tools\ant\types\resources\AbstractFileSetTest.java	1	1	5	0
File	AbstractHotDeploy	AbstractHotDeployTool.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\2ee\AbstractHotDeployTool.java	1	0	14	0
File	AbstractJUnit3Test	AbstractJUnit3TestMissed.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\JUnit3TestMissed.java	1	0	1	0
File	AbstractJUnit3Test	AbstractJUnit3TestNotMissed.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\JUnit3TestNotMissed.java	3	39	1	0
File	AbstractJarSigner	AbstractJarSignerTask.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\AbstractJarSignerTask.java	1	3	25	0
File	AbstractResourceCollectionWrapper	AbstractResourceCollectionWrapper.java	@I\src\main\org\apache\tools\ant\types\resources\AbstractResourceCollectionWrapper.java	1	4	12	0
File	AbstractScriptComp	AbstractScriptComponent.java	@I\src\main\org\apache\tools\ant\types\optional\AbstractScriptComponent.java	2	64	12	93
File	AbstractSelector	AbstractSelectorContainer.java	@I\src\main\org\apache\tools\ant\types\optional\AbstractSelectorContainer.java	1	4	33	41
File	AbstractSshMessage	AbstractSshMessage.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\ssh\AbstractSshMessage.java	1	4	20	25
File	AbstractTestMissed	AbstractTestMissed.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\JUnit3TestMissed.java	2	2	1	0
File	AbstractTestNotMissed	AbstractTestNotMissed.java	@I\src\main\org\apache\tools\ant\taskdefs\optional\JUnit3TestNotMissed.java	1	1	1	0

Figure 1: Apache Ant 1.10.1

Kind	Name	File	Entity_UniqueName	CountClassCoupled	CountClassDerived	CountDeclMethodAll	CountDeclMethod	MaxInheritanceTree	PercentLackOfCohesion
Package	(Unnamed_Package)	Task1.java	@l\Unnamed_Package@k3\Unnamed_Package@f\src\etc\tests	1	0	0	80	2	0
Public Class	A	A.java	@IA@k4A@f\src\etc\testcases\taskdefs\optional\depend\src1\	0	0	0	0	1	0
Public Class	A	A.java	@IA@k4A@f\src\etc\testcases\taskdefs\optional\depend\src1\	0	0	0	0	1	0
Public Class	A	A.java	@IA@k4A@f\src\etc\testcases\taskdefs\optional\depend\src1\	1	0	0	0	1	0
Public Class	A	A.java	@IA@k4A@f\src\etc\testcases\taskdefs\optional\depend\src5\	0	0	0	0	2	0
Private Static	A.Inner	A.java	@IA.Inner@k4A.Inner@f\src\etc\testcases\taskdefs\optional\di	0	0	0	0	1	0
Private Static	A.Inner	A.java	@IA.Inner@k4A.Inner@f\src\etc\testcases\taskdefs\optional\di	0	0	0	0	2	0
Private Static	A.Inner.Inner2	A.java	@IA.Inner.Inner2@k4A.Inner.Inner2@f\src\etc\testcases\taskde	0	0	0	0	2	0
File	A.java	A.java	@l\src\etc\testcases\taskdefs\optional\depend\src1\A.java	1	1	1	0	1	0
File	A.java	A.java	@l\src\etc\testcases\taskdefs\optional\depend\src2\A.java	3	0	1	0	1	0
File	A.java	A.java	@l\src\etc\testcases\taskdefs\optional\depend\src3\A.java	0	0	1	0	1	0
File	A.java	A.java	@l\src\etc\testcases\taskdefs\optional\depend\src5\A.java	2	0	3	0	2	0
File	ANTLR.java	ANTLR.java	@l\src\tests\unit\org\apache\tools\ant\taskdefs\dir2\A.java	0	4	0	3	2	0
File	ANTLRTest.java	ANTLRTest.java	@l\src\main\org\apache\tools\ant\taskdefs\optional\ANTLR.jav	0	4	0	24	1	0
Class	APrivate	A.java	@IAPrivate@k4APrivate@f\src\etc\testcases\taskdefs\optional\	0	4	0	0	1	0
File	AbstractAccessTask.java	AbstractAccessTask.java	@l\src\main\org\apache\tools\ant\taskdefs\optional\un\Abstr	1	0	3	6	2	0
File	AbstractAnalyzer.java	AbstractAnalyzer.java	@l\src\main\org\apache\tools\ant\util\depend\AbstractAnalyz	0	1	0	16	1	0
File	AbstractClasspathResource	AbstractClasspathResource.java	@l\src\main\org\apache\tools\ant\types\resources\AbstractCla	0	0	0	19	1	0
File	AbstractCvsTask.java	AbstractCvsTask.java	@l\src\main\org\apache\tools\ant\taskdefs\AbstractCvsTask.ja	1	0	1	46	1	0
File	AbstractCvsTaskTest.java	AbstractCvsTaskTest.java	@l\src\tests\unit\org\apache\tools\ant\taskdefs\AbstractCvsTa	0	0	1	5	2	0
File	AbstractFileSet.java	AbstractFileSet.java	@l\src\main\org\apache\tools\ant\types\AbstractFileSet.java	3	0	42	70	3	50
File	AbstractFileSetTest.java	AbstractFileSetTest.java	@l\src\tests\unit\org\apache\tools\ant\types\AbstractFileSetTe	9	0	43	7	3	40
File	AbstractHotDeploymentTool	AbstractHotDeploymentTool.java	@l\src\main\org\apache\tools\ant\taskdefs\optional\j2ee\Abstr	6	0	43	13	3	40
File	AbstractUnit3TestMissed	AbstractUnit3TestMissed.java	@l\src\tests\unit\org\example\unit\AbstractUnit3TestMissed.j	7	0	44	1	3	60
File	AbstractUnit3TestNotMiss	AbstractUnit3TestNotMiss.java	@l\src\tests\unit\org\example\unit\AbstractUnit3TestNotMiss	7	0	44	1	3	60
File	AbstractUnitResultForma	AbstractUnitResultFormatt.java	@l\src\main\org\apache\tools\ant\taskdefs\optional\unit\Abstr	4	0	2	23	1	0
File	AbstractSignatureTask	AbstractSignatureTask.java	@l\src\main\org\apache\tools\ant\taskdefs\AbstractSignatureT	10	0	6	25	1	50
File	AbstractResourceCollection	AbstractResourceCollection.java	@l\src\main\org\apache\tools\ant\types\resources\AbstractRes	10	0	6	12	1	50
File	AbstractScriptComponent	AbstractScriptComponent.java	@l\src\main\org\apache\tools\ant\types\optional\AbstractScrip	10	0	7	13	1	50
File	AbstractSelectorContainer	AbstractSelectorContainer.java	@l\src\main\org\apache\tools\ant\types\selectors\AbstractSele	10	0	7	34	1	50
File	AbstractSshMessage	AbstractSshMessage.java	@l\src\main\org\apache\tools\ant\taskdefs\optional\ssh\Abstr	5	0	43	19	3	53
File	AbstractTestMissed	AbstractTestMissed.java	@l\src\tests\unit\org\example\unit\AbstractTestMissed.java	1	0	3	1	1	33

Figure 2: Apache Ant 1.10.3

Kind	Name	File	Entity_UniqueName	CountClassCoupled	CountClassDerived	CountDeclMethodAll	CountDeclMethod	MaxInheritanceTree	PercentLackOfCohesion
Package	(Unnamed_Package)	Task1.java	@l\Unnamed_Package@k3\Unnamed_Package@f\apache-ant	1	0	80	0	2	0
Public Class	A	A.java	@IA@k4A@f\apache-ant-1.10.10\src\etc\testcases\taskdefs\opt	0	0	0	0	1	0
Public Class	A	A.java	@IA@k4A@f\apache-ant-1.10.10\src\etc\testcases\taskdefs\opt	1	0	0	0	1	0
Public Class	A	A.java	@IA@k4A@f\apache-ant-1.10.10\src\etc\testcases\taskdefs\opt	0	0	0	0	2	0
Private Static Class	A.Inner	A.java	@IA.Inner@k4A.Inner@f\apache-ant-1.10.10\src\etc\testcases,	0	0	0	0	1	0
Private Static Class	A.Inner	A.java	@IA.Inner@k4A.Inner@f\apache-ant-1.10.10\src\etc\testcases,	0	0	0	0	2	0
Private Static Class	A.Inner.Inner2	A.java	@IA.Inner.Inner2@k4A.Inner.Inner2@f\apache-ant-1.10.10\src	0	0	0	0	2	0
File	A.java	A.java	@l\apache-ant-1.10.10\src\etc\testcases\taskdefs\optional\dep	1	1	0	1	1	0
File	A.java	A.java	@l\apache-ant-1.10.10\src\etc\testcases\taskdefs\optional\dep	3	0	0	1	1	0
File	A.java	A.java	@l\apache-ant-1.10.10\src\etc\testcases\taskdefs\optional\dep	0	0	0	1	1	0
File	A.java	A.java	@l\apache-ant-1.10.10\src\etc\testcases\taskdefs\optional\dep	2	0	0	3	2	0
File	ANTLR.java	ANTLR.java	@l\apache-ant-1.10.10\src\tests\unit\org\apache\tools\ant\tas	0	4	3	0	2	0
File	ANTLRTest.java	ANTLRTest.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\taskdef	0	4	24	0	1	0
File	ANTLRTest.java	ANTLRTest.java	@l\apache-ant-1.10.10\src\tests\unit\org\apache\tools\ant\tas	0	4	18	0	1	0
Class	APrivate	A.java	@IAPrivate@k4APrivate@f\apache-ant-1.10.10\src\etc\testcas	0	4	0	0	1	0
File	AbstractAccessTask	AbstractAccessTask.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\taskdef	1	0	6	3	2	0
File	AbstractAnalyzer	AbstractAnalyzer.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\util\dep	0	1	16	0	1	0
File	AbstractClasspathResource	AbstractClasspathResource.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\types\ri	0	0	20	0	1	0
File	AbstractCvsTask	AbstractCvsTask.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\taskdef	1	0	46	1	1	0
File	AbstractCvsTaskTest	AbstractCvsTaskTest.java	@l\apache-ant-1.10.10\src\tests\unit\org\apache\tools\ant\tas	0	0	5	1	2	0
File	AbstractFileSet	AbstractFileSet.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\types\A	3	0	72	42	3	50
File	AbstractFileSetTest	AbstractFileSetTest.java	@l\apache-ant-1.10.10\src\tests\unit\org\apache\tools\ant\tas	9	0	23	43	3	40
File	AbstractHotDeploymentTool	AbstractHotDeploymentTool.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\taskdef	6	0	13	43	3	40
File	AbstractUnit3TestMissed	AbstractUnit3TestMissed.java	@l\apache-ant-1.10.10\src\tests\unit\org\example\unit\Abstr	7	0	1	44	3	60
File	AbstractUnit3TestNotMiss	AbstractUnit3TestNotMiss.java	@l\apache-ant-1.10.10\src\tests\unit\org\example\unit\Abstr	7	0	1	44	3	60
File	AbstractUnitResultForma	AbstractUnitResultFormatt.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\taskdef	4	0	23	2	1	0
File	AbstractSignatureTask	AbstractSignatureTask.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\taskdef	10	0	30	6	1	50
File	AbstractResourceCollection	AbstractResourceCollection.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\tas	10	0	3	6	1	50
File	AbstractScriptComponent	AbstractScriptComponent.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\types\o	10	0	13	7	1	50
File	AbstractSelectorContainer	AbstractSelectorContainer.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\types\s	10	0	13	7	1	50
File	AbstractSshMessage	AbstractSshMessage.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\types\	5	0	37	43	3	53
File	AbstractTestMissed	AbstractTestMissed.java	@l\apache-ant-1.10.10\src\main\org\apache\tools\ant\taskdef	1	0	19	3	1	33

Figure 3: Apache Ant 1.10.10

	A	B	C	D	E	F	G	H	I	J
	Kind	Name	File	Entity_UniqueName	CountDeclMethodAll	CountDeclMethod	CountClassCoupled	PercentLackOfCohesion	CountClassDerived	MaxInheritanceTree
1	Package	(Unnamed_Package)	Task1.java	@I((Unnamed_Package)@k3j(Unnamed_Package)@f./apache-ant-1.10.13/src/etc/	0	112	1	0	0	2
2	Public Class	A	.java	@IA@k3jA@f./apache-ant-1.10.13/src/etc/testcases/optional/depend/s	0	0	0	0	0	1
3	Public Class	A	.java	@IA@k3jA@f./apache-ant-1.10.13/src/etc/testcases/tasksdefs/optional/depend/s	0	0	0	0	0	1
4	Public Class	A	.java	@IA@k3jA@f./apache-ant-1.10.13/src/etc/testcases/tasksdefs/optional/depend/s	0	0	1	0	0	1
5	Public Class	A	.java	@IA@k3jA@f./apache-ant-1.10.13/src/etc/testcases/tasksdefs/optional/depend/s	0	0	0	0	0	2
6	Public Class	A	.java	@IA@k3jA@f./apache-ant-1.10.13/src/etc/testcases/tasksdefs/optional/depend/s	0	0	0	0	0	2
7	Private Static Cl A.Inner	A	.java	@IA.Inner@k3jA.Inner@f./apache-ant-1.10.13/src/etc/testcases/tasksdefi	0	0	0	0	0	1
8	Private Static Cl A.Inner	A	.java	@IA.Inner@k3jA.Inner@f./apache-ant-1.10.13/src/etc/testcases/tasksdefi	0	0	0	0	0	2
9	Private Static Cl A.Inner.Inner2	A	.java	@IA.Inner.Inner2@k3jA.Inner.Inner2@f./apache-ant-1.10.13/src/etc/testcase	0	0	0	0	0	2
10	File	A.java	A.java	@L/apache-ant-1.10.13/src/etc/testcases/tasksdefs/optional/depend/src/L.a	1	0	1	0	1	1
11	File	A.java	A.java	@L/apache-ant-1.10.13/src/etc/testcases/tasksdefs/optional/depend/src/A.ja	1	0	3	0	0	1
12	File	A.java	A.java	@L/apache-ant-1.10.13/src/etc/testcases/tasksdefs/optional/depend/src/A.ja	1	0	0	0	0	1
13	File	A.java	A.java	@L/apache-ant-1.10.13/src/etc/testcases/tasksdefs/optional/depend/src/S.a	3	0	2	0	0	2
14	File	A.java	A.java	@L/apache-ant-1.10.13/src/etc/junit/org/apache/tools/ant/tasksdef/dir/2.A.ja	0	3	0	0	4	2
15	File	ANTLR.java	ANTLR.java	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/tasksdef/optional/ANTLF	0	24	0	0	4	4
16	File	ANTLRTest.java	ANTLRTest.java	@L/apache-ant-1.10.13/src/etc/junit/org/apache/tools/ant/tasksdef/optiona	0	18	0	0	4	1
17	Class	APrivate	A.java	@IAPrivate@k3jA.Private@f./apache-ant-1.10.13/src/etc/testcases/tasksdef	0	0	0	0	4	1
18	File	AbstractAccessTask	AbstractAccessTa	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/tasksdef/optional/unix	3	6	1	0	0	2
19	File	AbstractAnalyzer	ja AbstractAnalyz	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/util/depend/AbstractAn	0	16	0	0	1	1
20	File	Abstractclasspath	AbstractClasspath	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/types/resources/Abstra	0	20	0	0	0	1
21	File	AbstractCsvTask	ja AbstractCsvTas	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/types/resources/Abstra	1	46	1	0	0	1
22	File	AbstractCsvTaskTes	AbstractCsvTaskTe	@L/apache-ant-1.10.13/src/etc/junit/org/apache/tools/ant/tasksdef/AbstractCv	1	5	0	0	0	2
23	File	AbstractFileSet	java AbstractFileSe	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/types/AbstractFileSetJa	42	7	3	50	0	0
24	File	AbstractFileSetTest	AbstractFileSetTes	@L/apache-ant-1.10.13/src/etc/junit/org/apache/tools/ant/types/AbstractFileSe	43	23	9	40	0	3
25	File	AbstractHotDeploy	AbstractHotDeplo	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/tasksdef/optiona/J2ee	43	13	6	40	0	3
26	File	AbstractUnit3Test	AbstractUnit3Test	@L/apache-ant-1.10.13/src/etc/junit/org/example/junit/AbstractUnit3TestMiss	44	1	7	60	0	3
27	File	AbstractUnit3Test	AbstractUnit3Test	@L/apache-ant-1.10.13/src/etc/junit/org/example/junit/AbstractUnit3TestNot	44	1	7	60	0	3
28	File	AbstractUnitResult	AbstractUnitResu	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/tasksdef/optiona/Junit	2	23	4	0	0	1
29	File	AbstractUnitSigner	T AbstractUnitSigne	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/tasksdef/AbstractUnitSi	6	30	10	50	0	1
30	File	AbstractNashornCc	AbstractNashornCc	@L/apache-ant-1.10.13/src/etc/junit/org/apache/tools/ant/tasksdef/optionals	6	3	10	50	0	1
31	File	AbstractResourceCom	AbstractResourceCom	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/types/resources/Abstra	7	13	10	50	0	1
32	File	AbstractScriptComp	AbstractScriptComp	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/types/optional/Abstra	7	14	10	50	0	1
33	File	AbstractSelectorCo	AbstractSelectorCo	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/types/selectors/Abstra	43	37	5	53	0	3
34	File	AbstractSshMessage	AbstractSshMessa	@L/apache-ant-1.10.13/src/main/org/apache/tools/ant/tasksdef/optiona/ssh/A	3	19	1	33	0	1

Figure 4: Apache Ant 1.10.13

All the FOUR versions were analysed, and the averages are shown in the below figure 5, shows the graphs for the metrics and their trends.

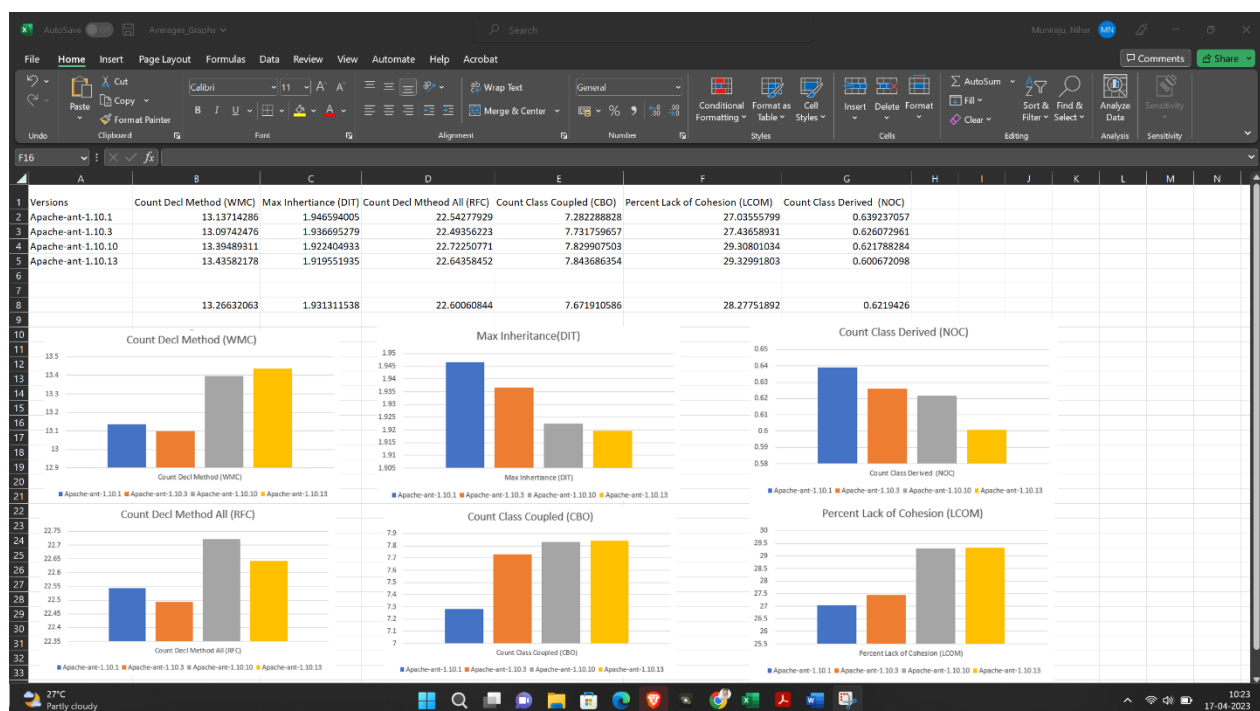


Figure 5: Averages and the graphs

Analysing Apache-Ant 1.10.1



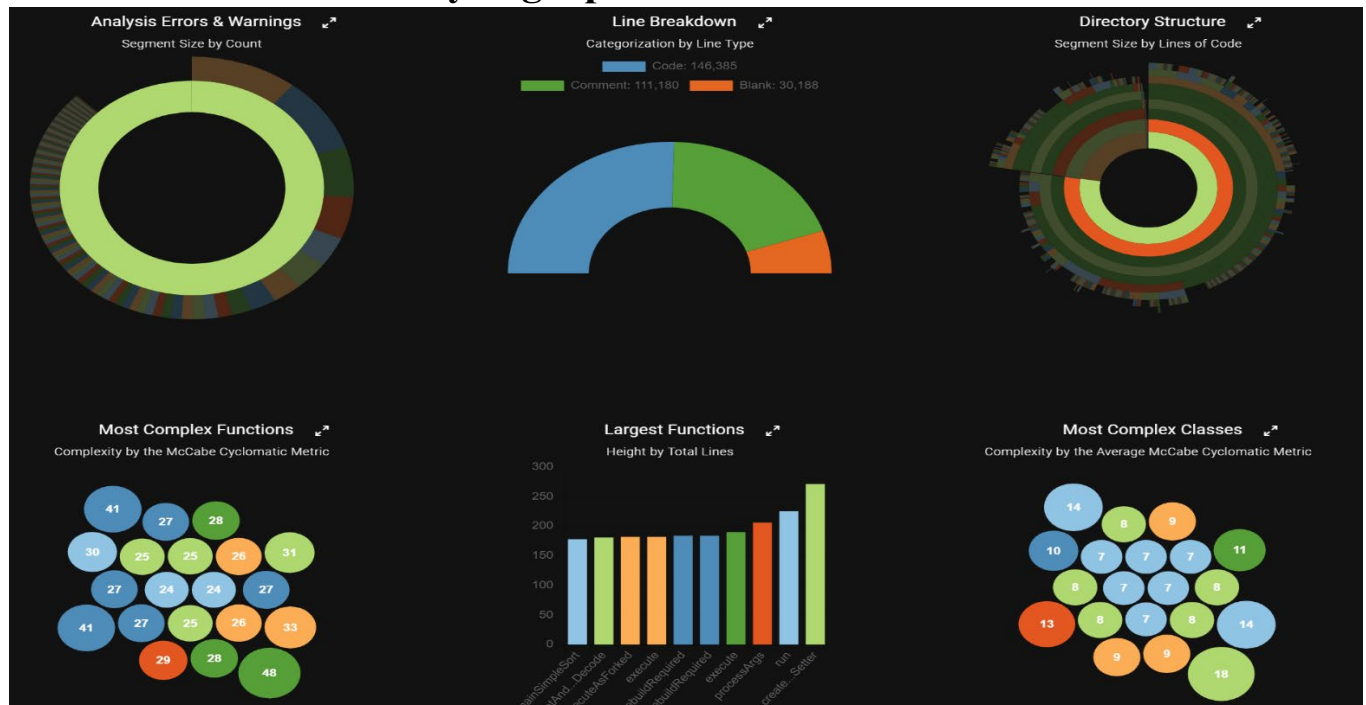
Analysing Apache-Ant 1.10.3



Analysing Apache-Ant 1.10.10



Analysing Apache-Ant 1.10.13



Examples:

1. Calculate WMC [Weighted Methods per Class]:

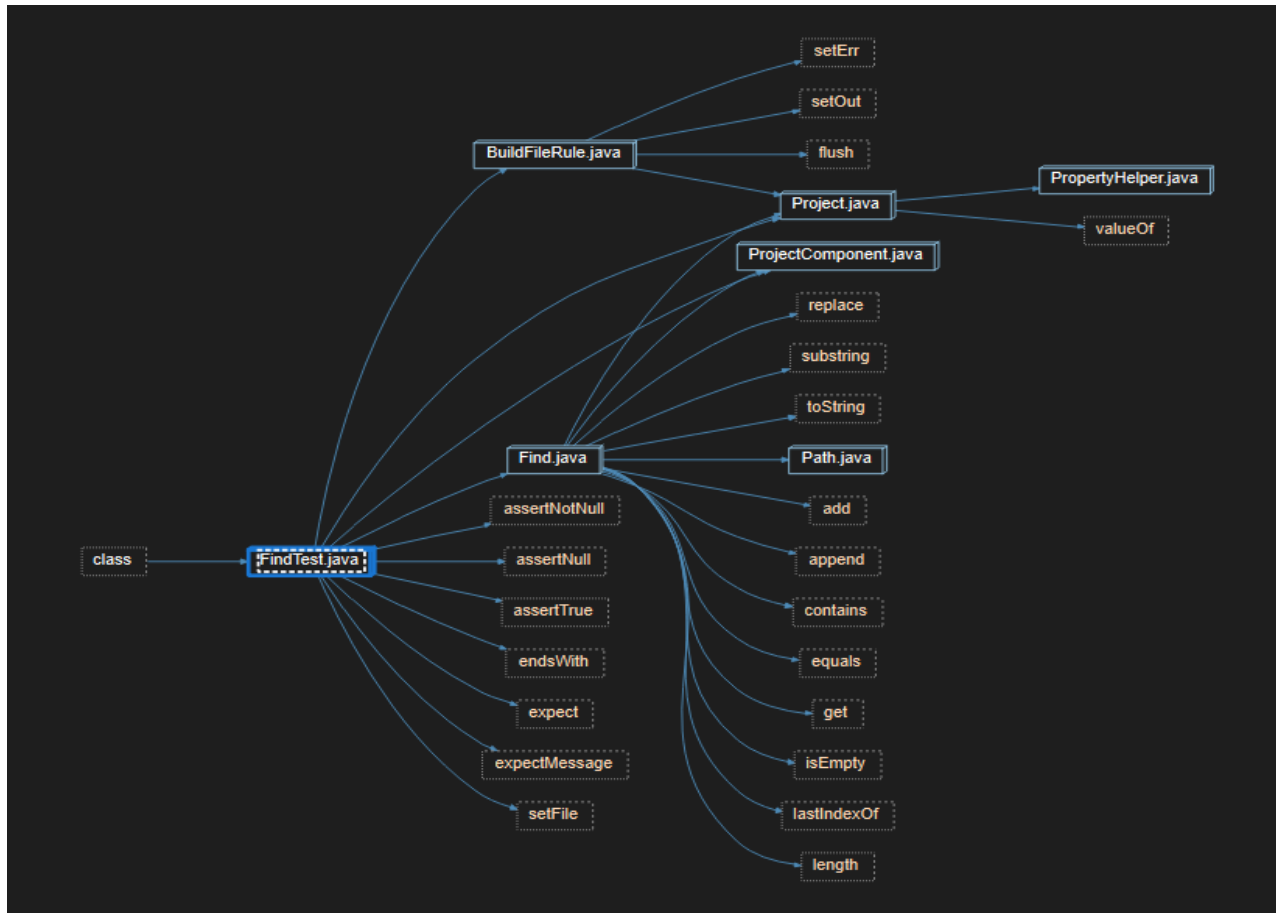
```
18 import org.apache.tools.ant.Task;
19 import org.apache.tools.ant.BuildException;
20 import org.apache.tools.ant.types.FileSet;
21 import org.apache.tools.ant.DirectoryScanner;
22 import java.util.ArrayList;
23 import java.util.List;
24 import java.io.File;
25 public class Find extends Task {
26     private String file;
27     private String location;
28     private List<FileSet> filesets = new ArrayList<>();
29
30     public void setFile(String file) {
31         this.file = file;
32     }
33     public void setLocation(String location) {
34         this.location = location;
35     }
36     public void addFileset(FileSet fileset) {
37         filesets.add(fileset);
38     }
39     protected void validate() {
40         if (file == null) throw new BuildException("file not set");
41         if (location == null) throw new BuildException("location not set");
42         if (filesets.size() < 1) throw new BuildException("fileset not set");
43     }
44     public void execute2() {
45         validate();
46         String foundLocation = null;
47         for (FileSet fs : filesets) {
48             DirectoryScanner ds = fs.getDirectoryScanner(getProject());
49             File base = ds.getBasedir();
50             for (String includedFile : ds.getIncludedFiles()) {
51                 String filename = includedFile.replace('\\', '/');
52                 filename = filename.substring(filename.lastIndexOf("/") + 1);
53                 if (foundLocation == null && file.equals(filename)) {
54                     File found = new File(base, includedFile);
55                     foundLocation = found.getAbsolutePath();
56                 }
57             }
58         }
59         if (foundLocation != null)
60             getProject().setNewProperty(location, foundLocation);
61     }
62 }
63
```

To Calculate WMC :—
⇒ Assigning weights for the method based on its complexity in ascending order.

- public void setFile → complexity 2.
- public void setLocation → complexity 3.
- public void addFileset → complexity 4.
- public void validate → complexity 5.
- public void execute2 → complexity 6.

$$WMC = (2 \times 1) + (3 \times 1) + (4 \times 1) + (5 \times 1) + (6 \times 1) = 20.$$

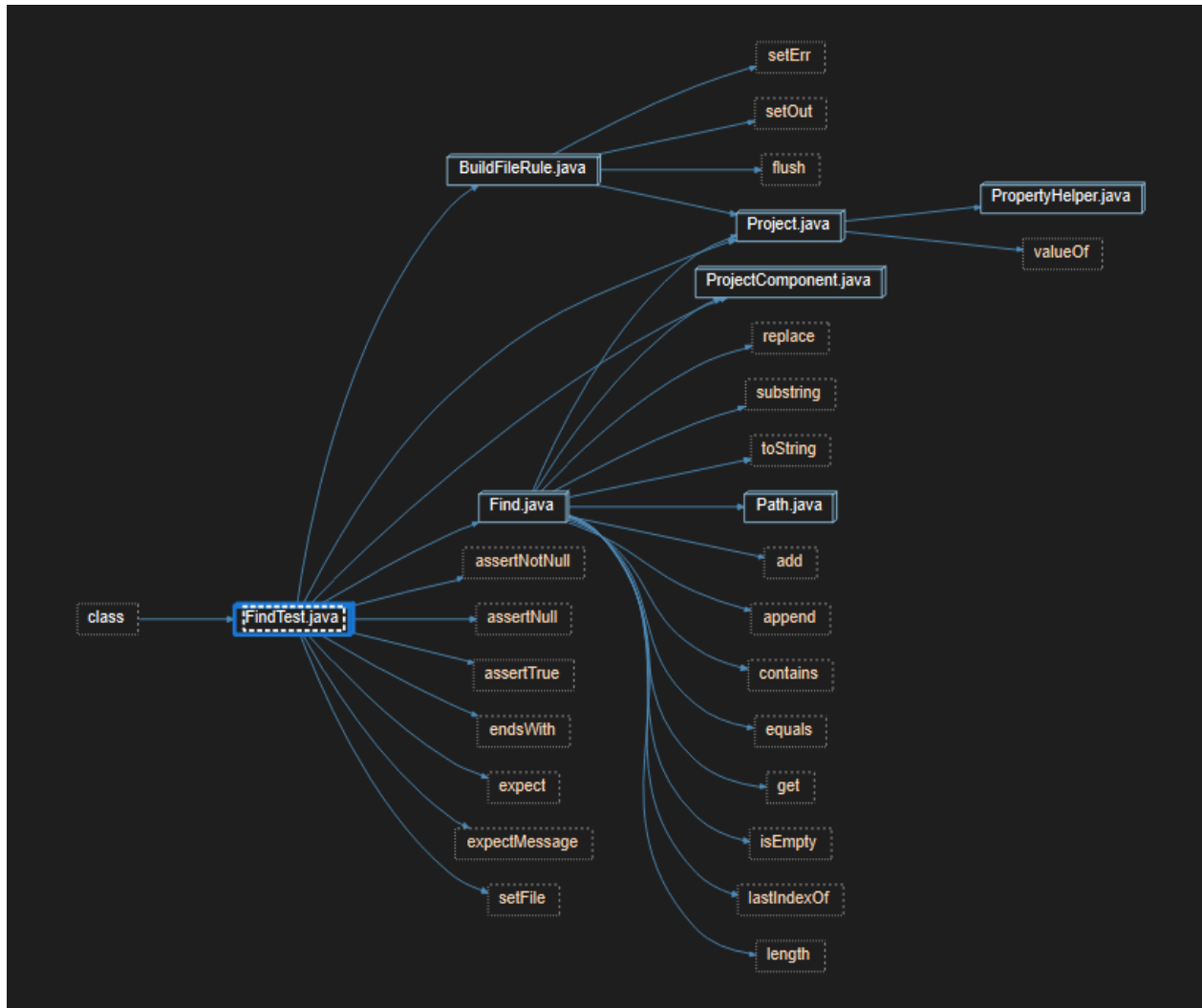
2. Calculate DIT [Depth of Inheritance Tree]:



DIT [Depth of Inheritance Tree].
To Calculate DIT:-

- 1) $DIT(\text{FindTest}) = 0$.
- 2) $DIT(\text{FindJava}) = 1$.
- 3) $DIT(\text{Project}) = 2$.
- 4) $DIT(\text{PropertyHelper}) = 3$.

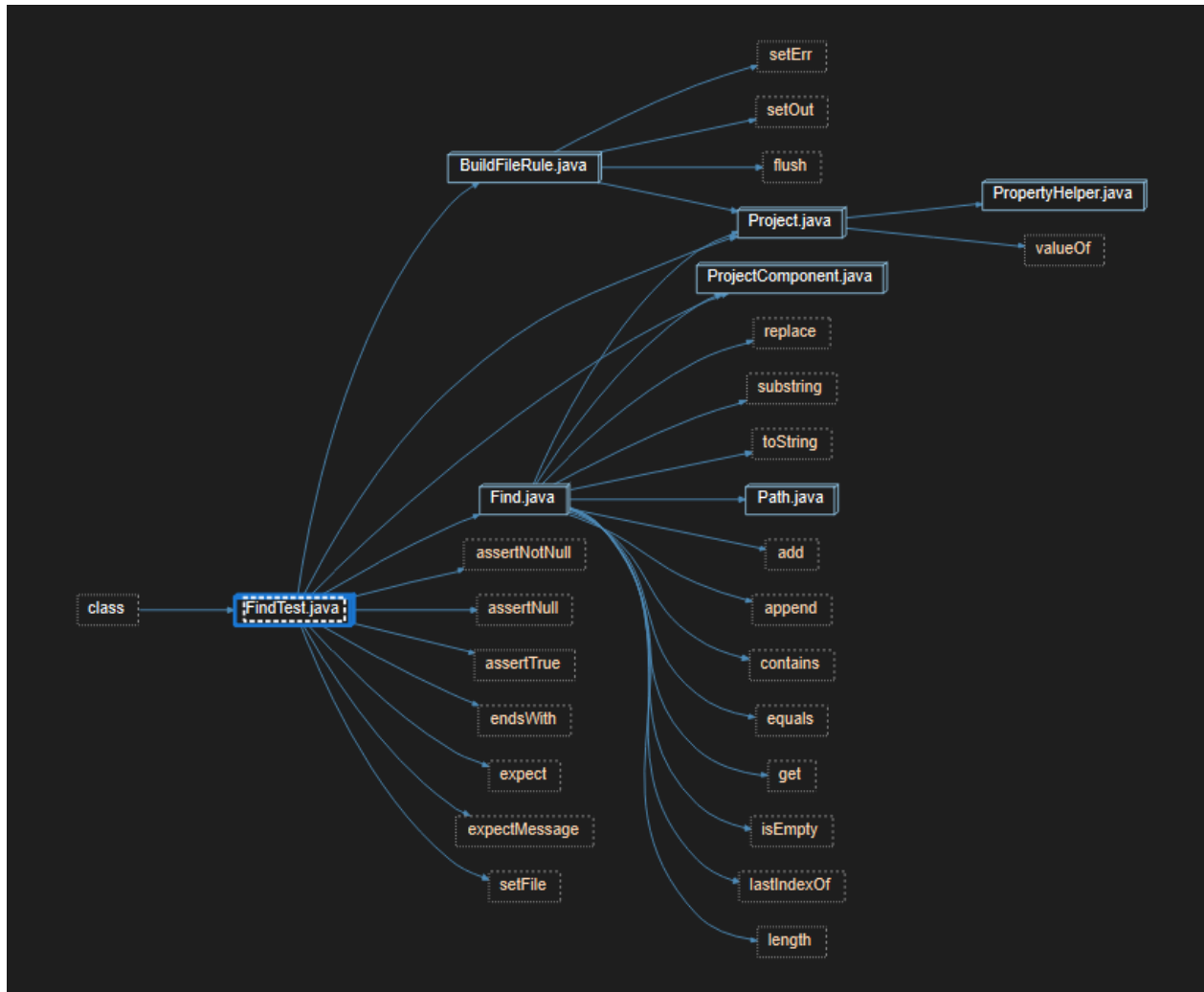
3. Calculate NOC [Number of Children]:



NOC [Number of Children]

- 1) NOC [FindTest] = 2
- 2) NOC [BuildFileRule] = 1
- 3) NOC [Find] = 3
- 4) NOC [Path] = 0
- 5) NOC [Project] = 1
- 6) NOC [ProjectComponent] = 0
- 7) NOC [PropertyHelper] = 0

4. Calculate COB [Coupling Between Objects]:



Coupling Between Objects [CBO] .

⇒ The CBO is 6, which are Objects of classes that are affecting the class encapsulation by getting ratio of the number of links to the number of classes.

Evaluation

The Apache Ant software is evaluated with 4 different Apache Ant versions:

6%	2	12,329	270,033	1,225	1,808	13,784
Parse Accuracy	Errors	Warnings	Lines	Files	Classes	Functions

Version 1.10.1

In the above Version of Apache Ant, the Parse Accuracy is 6% which shows that the functions written from the class might have caused that accuracy. The 1808 classes and 13,784 functions have around 12,329 warnings and 2 errors. In the next version it might improve with a bigger boundary. These codes of lines were implemented in java.

5%	2	13,656	273,469	1,263	1,821	14,242
Parse Accuracy	Errors	Warnings	Lines	Files	Classes	Functions

Version 1.10.3

The Version 1.10.3 is better than 1.10.1 because of the Parse Accuracy improving to 5% as the number of classes and functions increase to 1821 and 14,242. The warnings might have increased as increase with the number of lines of code, but the Errors remain constant with 2.

5%	2	15,035	285,222	1,322	1,894	15,402
Parse Accuracy	Errors	Warnings	Lines	Files	Classes	Functions

Version 1.10.10

In the Version 1.10.10, the classes have increased, and functions have increased to 1894 and 15,402 but still the Parse Accuracy is 5% with having the same constant of 2 Errors. But the Warnings have raised up instantly as the number of Lines are increasing to 15,035.

5%	2	15,253	286,891	1,325	1,911	15,553
Parse Accuracy	Errors	Warnings	Lines	Files	Classes	Functions

Version 1.10.13

increasing to 15,035. The Version 1.10.13 has major change with the increase in classes from all the previous versions to 1911. And the functions have significantly become more 15,553 which are more functions than the before versions but still the Parse Accuracy is 5% and the Errors are 2. The warnings too have simultaneously increased as increased with the line of Code.

Recommendation.

Apache Ant being a sophisticated rescores with a more complex system with my recommendation as follows:

The metrics analysed seems to show the weakness and strengths of a given system for each version in Java. In Apache Ant with the increase of Number of Classes and Functions the Warnings increase but the Errors and Parse Accuracy remain constant except in the first Version of 1.10.1. Due to the increase of the

lines of code significantly from the number of files from classes and functions the graphs of all the Complex functions, Analysis of errors and warnings, largest functions and the Most complex classes change in every version of Apache Ant.

Apache Ant should reduce the max inheritance tree and increase more classes for the parser accuracy to increase. This will reduce the percentage cohesion loss.