Bayesian Modeling for Software Quality

By

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Today's agenda

- Progress Report
- PhD Plan
- Next Step
- Next meeting

Can we predict bug using software metrics?

Progress report -> PhD plan -> Next Step -> Next meeting

defect-reports.arff

Relation: defect-reports

No.	id	description	priority	project	project_name	title	type
25917	283308.0	A tab for the jmx console that grabs information fro...	Major	FELIX	Felix	A graphical tab to remotely get memory activity	New Feature
25916	283307.0	This MBean / Graphical couple is able to remotely in...	Major	FELIX	Felix	A graphical tab to remotely interact with obr	New Feature
13068	135171.0	We need a .gitignore file under nutch/ so git does no...	Trivial	NUTCH	Nutch	A .gitignore file for Nutch	Improvement
4289	60889.0	Should be work with JSP and Facelets	Major		MyFaces Tobago	A Bean-Tag or CRUD-Tag to create dynamic pages with low effort	New Feature
47466	501275.0	try examination example with exam set 2: after initia...	Major	PLANNER	OptaPlanner	A BestSolutionChangedEvent should be fired when a StartingSolutionInit...	Bug
28177	308725.0	Several people have asked if ManifoldCF supports C...	Major	CONNECTO...	ManifoldCF	A CMIS connector would be helpful	Improvement
6851	85882.0	This bug is a little symetric of SMXCOMP-446 (a CXF...	Major		ServiceMix Components	A CXF-BC provider used with WS-RM sends the CreateSequence request ...	Bug
6721	84487.0	Clob cannot be directly be consumed by Solr. So Jdb...	Major	SOLR	Solr	A Clobtransformer to read strings from Clob	Improvement
6353	80795.0	This means you cant try and create the collection ag...	Major	SOLR	Solr	A Collection that is only partially created and then deleted will leave pre ...	Bug
1246	32119.0	A DIV tag that utilized Ajax to obtain its contents. S...	Major	XSTR	XStream	A Currency converter	Improvement
19412	197278.0	See the following comment for detailed description.	Major		Hadoop HDFS	A Distributed and Cooperative NameNode Cluster for a Highly-Available ...	New Feature
1820	38999.0	A few of the projects were missing site.xml site desc...	Major	WICKET	Wicket	A Few Wicket Projects are Missing site.xml and wicket-site-skin	Bug
51153	556158.0	I have attached a patch that provides a Gradle build ...	Major	GROOVY	groovy	A Gradle build for Groovy	New Feature
52532	575089.0	See JBSEAM-4276.Patch proposed in JBSEAM-4276 i...	Blocker		JBoss Enterprise Appli...	A JBDS generated WAR project with reverse-engineered entities doesnt ...	Bug
58047	645660.0	A patch proposed in JBSEAM-4276 is not applied int...	Blocker		Developer Studio (JBo...	A JBDS generated WAR project with reverse-engineered entities doesnt ...	Bug
38880	413151.0	A JobExecution does not need a start time until it act...	Minor		Spring Batch	A JobExecution does not export a start time until it actually starts	Bug
49068	523929.0	Non-leaf nodes shouldnt have a layerinfo component...	Major	MAPFACES	MapFaces	A LayerInfo component is added even if the node is not a leaf	Bug
7074	88685.0	It would be useful if service-mix provided a store im...	Major		ServiceMix	A MongoDB Store would be usefull	New Feature
6404	81524.0	Id like to fix this for 4 - its a simple fix.	Blocker	SOLR	Solr	A PeerSync attempt to its replicas by a candidate leader should not fail o...	Bug
5323	72970.0	We could do a reference implementation of the Load...	Major	STRATOS	Stratos	A Reference Load Balancer Extenaion API Implementation for HAProxy	Sub-task
40133	425190.0	A Registry of projects should be maintained. Curren...	Major	UDIG	uDIG	A Registry of projects should be maintained.	Bug
6730	84550.0	This is same as SOLR-139. A new issue is opened so...	Major	SOLR	Solr	A RequestProcessor to support updates	New Feature
35550	376598.0	We need to resolve this issue. Major case	Major	ABDERA	Abdera	A Runtime Exception Problem	Bug
33218	359243.0	A SOAP 1.2 Message with a SWARef attachment is d...	Major	AXIOM	Axiom	A SOAP 1.2 SWARef Message is denied	Bug
42515	443376.0	see attached screenshot. There should be a cache so...	Major	SONAR	SonarQube	A SQL Select Query is done on Rules table each time a new violation is s...	Improvement
55096	608707.0	The simple plugin tutorial has not been updated fro...	Major	GEOS	GeoServer	A Simple PlugIn tutorial is not available in the new docs for geoserver ve...	Improvement
6501	82590.0	This is starting to really bug me because tests almos...	Major	SOLR	Solr	A SolrIndexSearcher can be left open if the executor rejects a task.	Bug
36588	380099.0	It could be useful if a state can extend more than on...	Minor		Spring Web Flow	A State should be able to extend more than one states	Improvement
32198	347338.0	"The web application we are buildng in this tutorial ...	Trivial	BEEHIVE	Beehive	A Typo in tutorial_pageflow.html	Bug
19000	195423.0	A UDF that can export data to JDBC databases.	Minor	HIVE	Hive	A UDF that can export data to JDBC databases.	New Feature
59731	668913.0	Because of new class hierarchy and co-variant return...	Blocker	ISPN	Infinispan	A Weld upgrade is needed	Bug
4290	60890.0	Should be work with JSP and Facelets.	Major		MyFaces Tobago	A Wizard-Tag to create dynamic wizard pages with low effort	New Feature
2059	41215.0	It propably would make sense to have a Set of "Attri...	Minor	VYSPER	VYSPER	A XMLElement might have duplicate attributes which isnt allowed in XML	Bug

| WMC	Weighted methods per class
LCOM	Lack of cohesion in methods
LOC	Lines of Code
RFC	The number of different methods that can be executed when an object of that class receives a message
NOC	Number of classes
Ca	How many other classes use that specific class
Ce	How many other classes is used by that specific class
CBO	The number of classes coupled to a given class
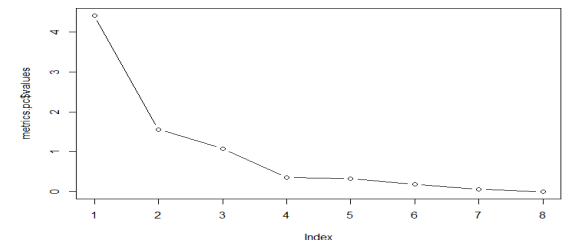
ckjm — Chidamber and Kemerer Java Metrics

www.spinellis.gr/sw/ckjm/
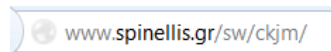
Relation: defect-metrics-v2

No.	name	project_count	bug_count	new_feature_count	improvement_count	sub_task_count	blocker_count	critical_count	major_count	minor_count	trivial_count	NOC	WMC	CBO	RFC	LCOM	Ca	Ce	LOC
1	CXF	389.0	167.0	26.0	116.0	20.0	0.0	4.0	312.0	65.0	8.0	1732.0	3.93	3.45	10.6	24.04	1.69	1.93	75.81
2	HBASE	1126.0	471.0	47.0	289.0	132.0	50.0	66.0	699.0	217.0	94.0	4026.0	3.95	5.13	12.22	37.91	2.58	2.82	105.38
3	KARAF	316.0	100.0	25.0	88.0	15.0	6.0	5.0	271.0	29.0	5.0	328.0	2.84	1.74	7.68	14.57	0.96	0.96	78.18
4	SONAR	577.0	124.0	69.0	304.0	22.0	1.0	17.0	417.0	126.0	16.0	194.0	4.27	2.01	10.3	94.42	1.08	1.08	84.06
5	JBPM	447.0	117.0	0.0	0.0	17.0	5.0	15.0	366.0	46.0	1.0	178.0	2.92	4.48	12.61	8.19	0.99	3.51	121.78
6	FABRICTH...	209.0	70.0	87.0	47.0	1.0	7.0	11.0	160.0	29.0	2.0	544.0	2.47	4.48	9.25	5.57	0.82	3.75	61.59
7	NUTCH	250.0	67.0	30.0	96.0	35.0	1.0	5.0	128.0	87.0	29.0	534.0	3.17	5.42	13.41	7.63	1.48	4.06	103.57
8	CMIS	121.0	41.0	14.0	39.0	9.0	1.0	4.0	79.0	36.0	1.0	908.0	4.61	3.35	10.51	106.48	1.15	2.29	85.06
9	PIG	336.0	148.0	40.0	89.0	28.0	8.0	11.0	265.0	38.0	14.0	466.0	2.59	3.73	10.46	7.03	0.42	3.35	75.27
10	OPENEJB	291.0	73.0	29.0	43.0	93.0	2.0	1.0	258.0	28.0	2.0	1664.0	3.34	3.78	11.33	18.68	1.65	2.24	92.42
11	OPENNLP	233.0	33.0	17.0	123.0	3.0	0.0	0.0	117.0	108.0	8.0	744.0	2.83	4.43	9.51	8.83	2.1	2.4	77.17
12	JBRULES	376.0	127.0	0.0	0.0	12.0	5.0	16.0	325.0	25.0	2.0	3874.0	6.1	6.72	12.95	80.91	2.91	4.02	92.85
13	ARQ	215.0	40.0	0.0	0.0	3.0	2.0	10.0	171.0	27.0	1.0	6708.0	3.9	6.04	9.25	40.67	3.13	3.18	73.99
14	MILYN	127.0	30.0	35.0	27.0	10.0	3.0	2.0	106.0	15.0	1.0	1540.0	3.16	4.34	9.41	13.5	2.07	2.37	65.12
15	COCOON	101.0	56.0	6.0	22.0	6.0	1.0	3.0	73.0	22.0	2.0	234.0	3.88	3.68	12.84	19.43	0.65	3.18	116.17
16	AVRO	206.0	65.0	45.0	77.0	5.0	7.0	2.0	158.0	34.0	5.0	358.0	3.61	3.34	9.39	16.23	1.74	1.86	76.92
17	BOOKKEEPER	209.0	82.0	14.0	57.0	45.0	11.0	3.0	153.0	36.0	6.0	2720.0	4.78	4.51	9.95	59.14	2.38	2.63	67.93
18	MAHOUT	155.0	52.0	16.0	65.0	6.0	0.0	0.0	88.0	52.0	15.0	1760.0	3.14	4.79	10.8	8.17	1.56	3.36	75.14
19	SHINDIG	214.0	88.0	25.0	79.0	6.0	3.0	2.0	146.0	54.0	9.0	448.0	2.73	2.77	8.07	8.81	1.04	1.89	49.68
20	SQOOP	228.0	66.0	30.0	53.0	45.0	11.0	3.0	171.0	26.0	17.0	950.0	2.79	3.7	9.95	36.08	1.27	2.49	75.5

Factor plot for software metrics principle components
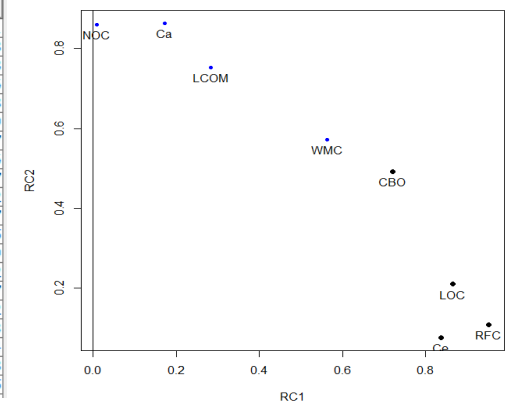
Scatterplot for Average Bug and C&K Metrics
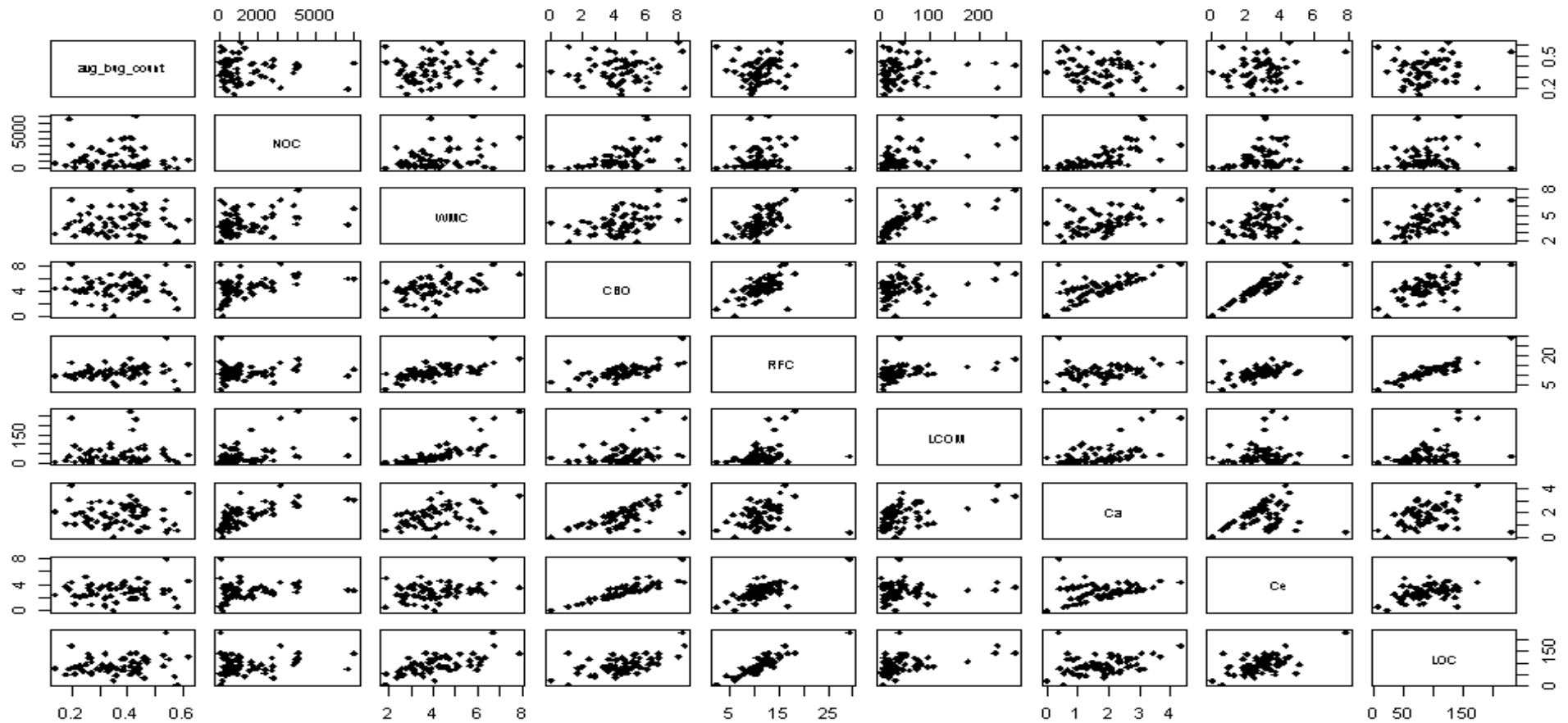
Scatterplot for Critical Bug and C&K Metrics
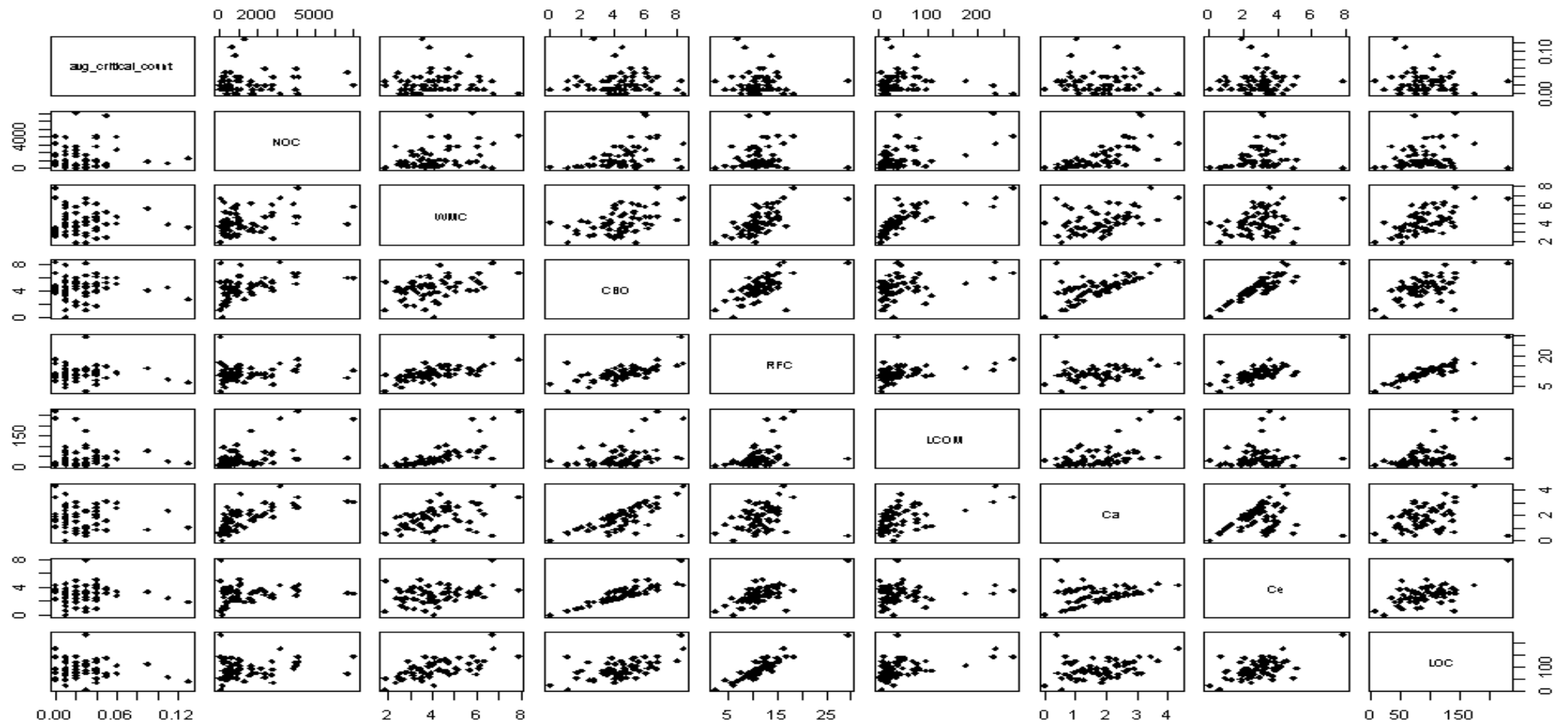
Scatterplot for Blocker Bug and C&K Metrics

Average reported bugs

Average critical bugs

Average blocker bugs
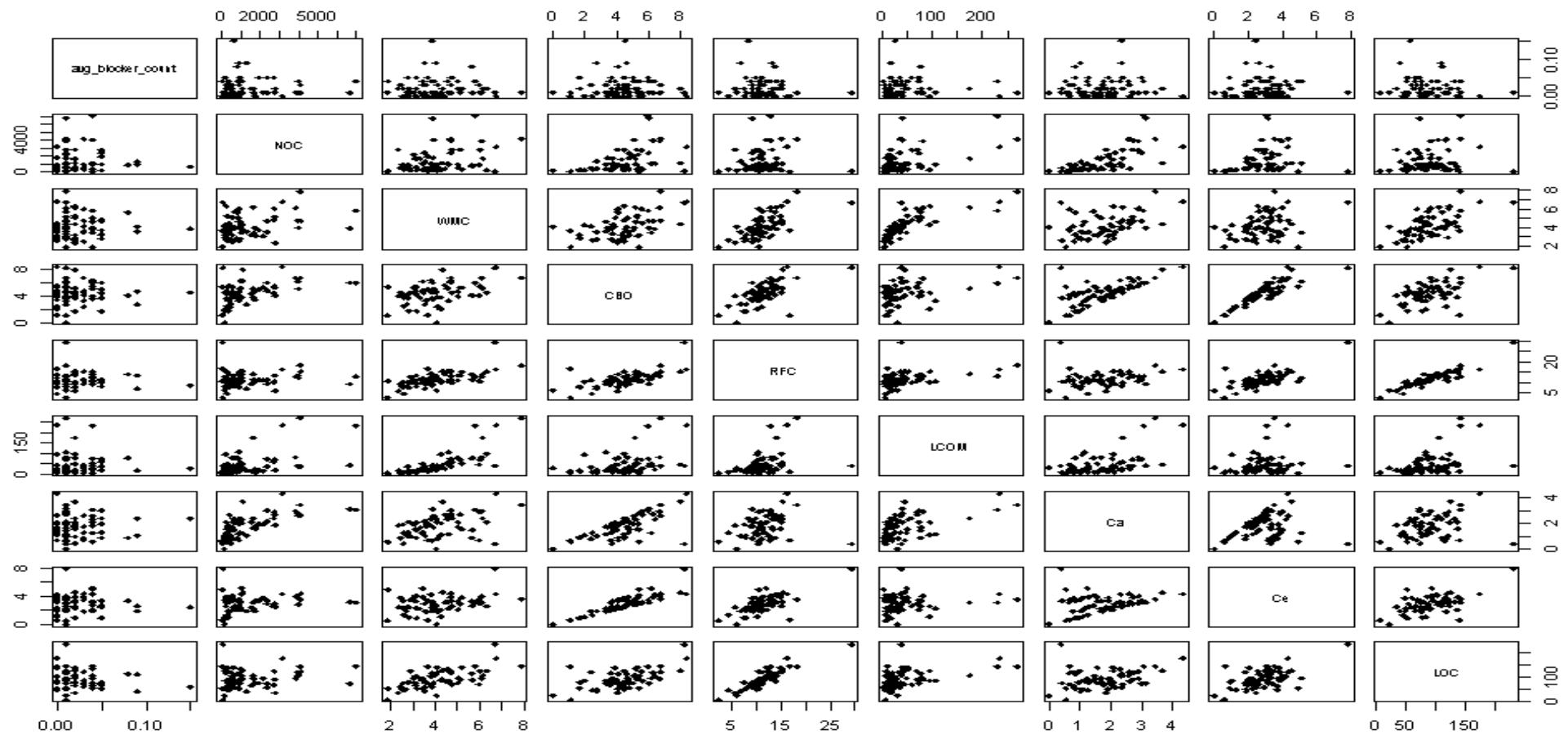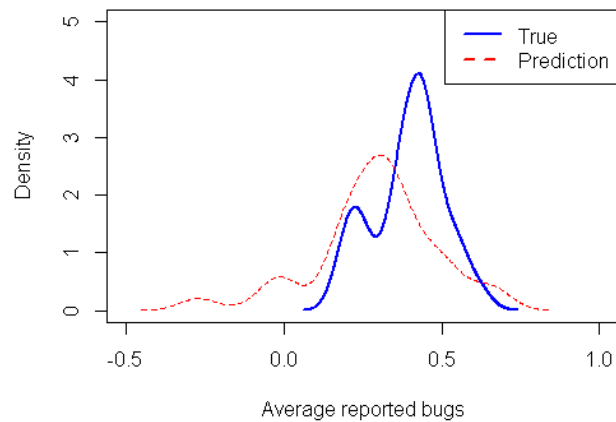
```
> #regression summary for
  continuous bug_count and metrics
> summary(metrics.test$avg_bug_count)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.1800  0.3425  0.4150  0.3947  0.4600  0.6200
> summary(metrics.test$pred_avg_bug_count)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
-0.2700  0.2000  0.3000  0.2925  0.3800  0.6700
```
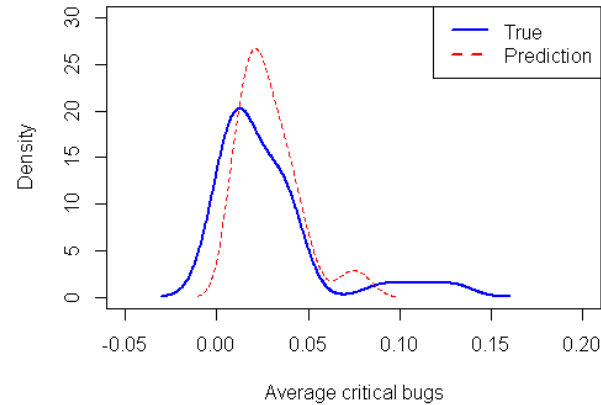
```
> #regression summary for
continuous critical_count and metrics
> summary(metrics.test$avg_critical_count)
    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.00000 0.01000 0.02000 0.02781 0.04000 0.13000
> summary(metrics.test$pred_avg_critical_count)
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.01000 0.02000 0.02500 0.02875 0.04000 0.08000
```
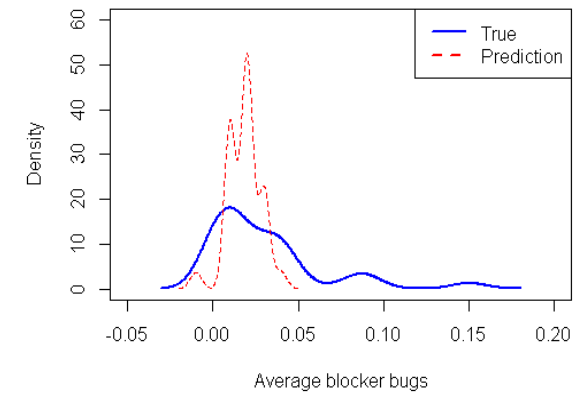
```
> #regression summary for
continuous blocker_count and metrics
> summary(metrics.test$avg_blocker_count)
    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
 0.00000 0.01000 0.02000 0.02969 0.04000 0.15000
> summary(metrics.test$pred_avg_blocker_count)
    Min.  1st Qu.  Median    Mean  3rd Qu.    Max.
-0.01000  0.01000  0.02000  0.01844  0.02000  0.04000
```

project_count Numeric	bug_count Numeric	new_feature_count Numeric	improvement_count Numeric	sub_task_count Numeric	blocker_count Numeric	critical_count Numeric	major_count Numeric	minor_count Numeric	trivial_count Numeric	NOC Numeric	WMC Numeric	CBO Numeric	RFC Numeric	LCOM Numeric	Ca Numeric	Ce Numeric	**LOC** Numeric

Systematic trials:

Model 1: all continuous – bug

Model 2: discritize bug (2 categories) and continuous metrices

Model 3: discritize bug (3 categories) and continuous metrices

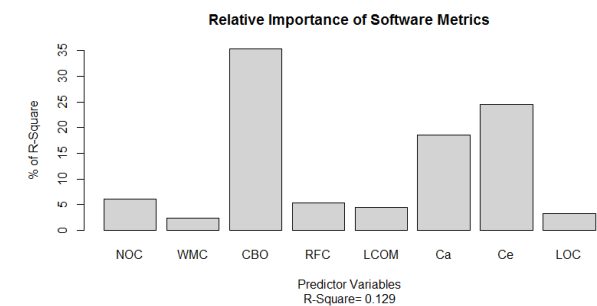**Model 4**: discritize critical (3 categories) and continuous metrices

Model 5: discritize blocker (3 categories) and continuous metrices

Model 6: discritize bug (3 categories) and discritize (2 categories) metrices

Model 7: discritize bug (3 categories) and discritize (3 categories) metrices

Model 8: Reduced model (discritize bug and continous predictor)

Model 9: Reduced model (discritize bug and metrices)

model	residuals	crossv. r-square	f-statistic	p-value
1	0.000781	0.0884	0.6424	0.7385
2	-0.1144	**0.1443**	1.118	0.3668
3	0.02061	0.09594	0.703	0.6874
4	0.0028	**0.145**	1.124	0.3630
5	0.02765	**0.1446**	1.120	0.3655
6	0.00219	0.1035	0.7651	0.6346
7	0.647	**0.1466**	1.138	0.3541
8	0.03699	0.06465	1.336	0.2714
9	0.0000	0.03734	0.750	0.5268

Relative Importance of Software Metrics

Predictor Variables
R-Square= 0.129

M-2: Bug   M-4: Critical   M-5: Blocker

AMBARI	HBASE	HBASE
HBASE	CLOUDSTACK	METAMODEL
HIVE	ASIX2	CLOUDSTACK
AXIS2	GRAILS	AXIS2
UIMA	METAMODEL	GRAILS

Can we predict bug using software metrics?
Although some model performs relatively better, $R^2 < 2$ means the overall predictive performance is not acceptable.

So, what is achieved so far?

Progress report -> **PhD plan** -> Next Step -> Next meeting

Research Phases

To Do (5)	Working On (2)	Done (0)
+	Literature Review ID 1	
Infer Network Structure with K2 ID 3	Bayesian Data Analysis ID 2	
Component Prediction ID 4		
Subclass Discovery ID 5		
Active Learning ID 6		
Writing Thesis for Graduation ID 7		
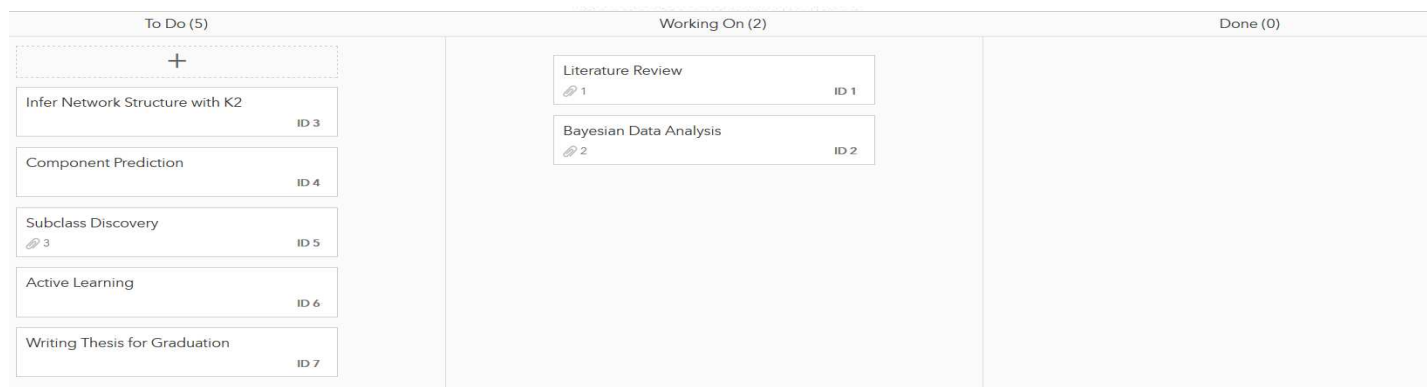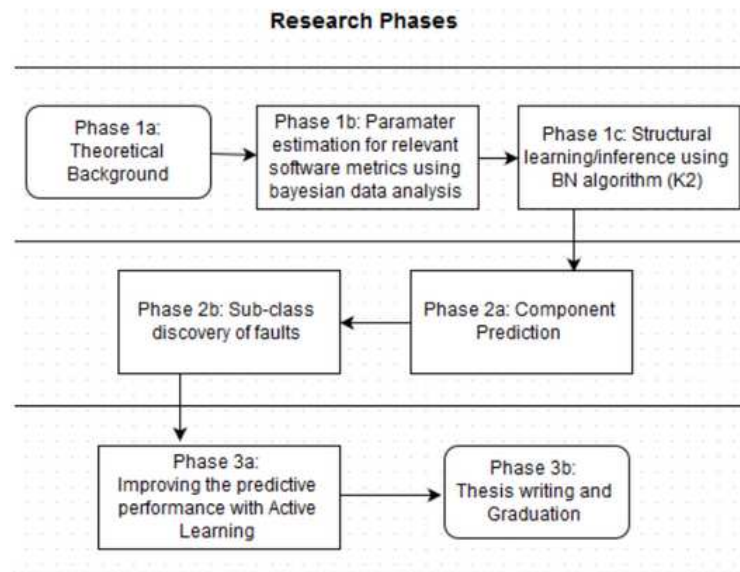
Achievements so far…

- The analysis sets the scene for future research in K2 (principle component part)

- Findings can be included in lit-review, OR we can wait until structure learning with K2 is done.

- Gained hands-on practical experience with descriptive statistics and various data mining algorithns (logistic, linear, svm, näive bayes) using R programing.

Prepare first publication? ..... Or, continue with K2 structure learning?

- ## Project roadmap

	Q1 2015	Q2 2015	Q3 2015	Q4 2015	Q1 2016	Q2 2016	Q3 2016	Q4 2016	Q1 2017	Q2 2017	Q3 2017	Q4 2017	Q1 2018	Q2 2018	Q3 2018	Q4 2018
Phase 1: 960 hrs (aprox.)																
Theoretical Background	DONE	WIP	TODO													
Bayesian Data Analysis	DONE	WIP														
Infer Network Structure with K2	TODO															
Phase 2: 2400 hrs (aprox.)																
Component Prediction				TODO	TODO	TODO										
Subclass Discovery					TODO	TODO										
Phase 3: 2400 hrs (aprox.)																
Active Learning							TODO	TODO	TODO							
Thesis Writing			TODO		TODO		TODO	TODO	TODO	TODO	TODO	TODO				
Color Code	TODO	WIP	DONE													

In 2-3 weeks

Result Expected: ?