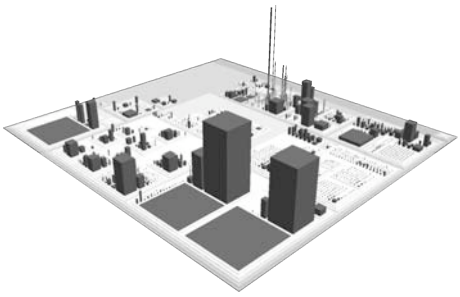
visualizations for code metrics



NEAL FORD software architect / meme wrangler

ThoughtWorks

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www.thoughtworks.com
blog: memeagora.blogspot.com
twitter: neal4d

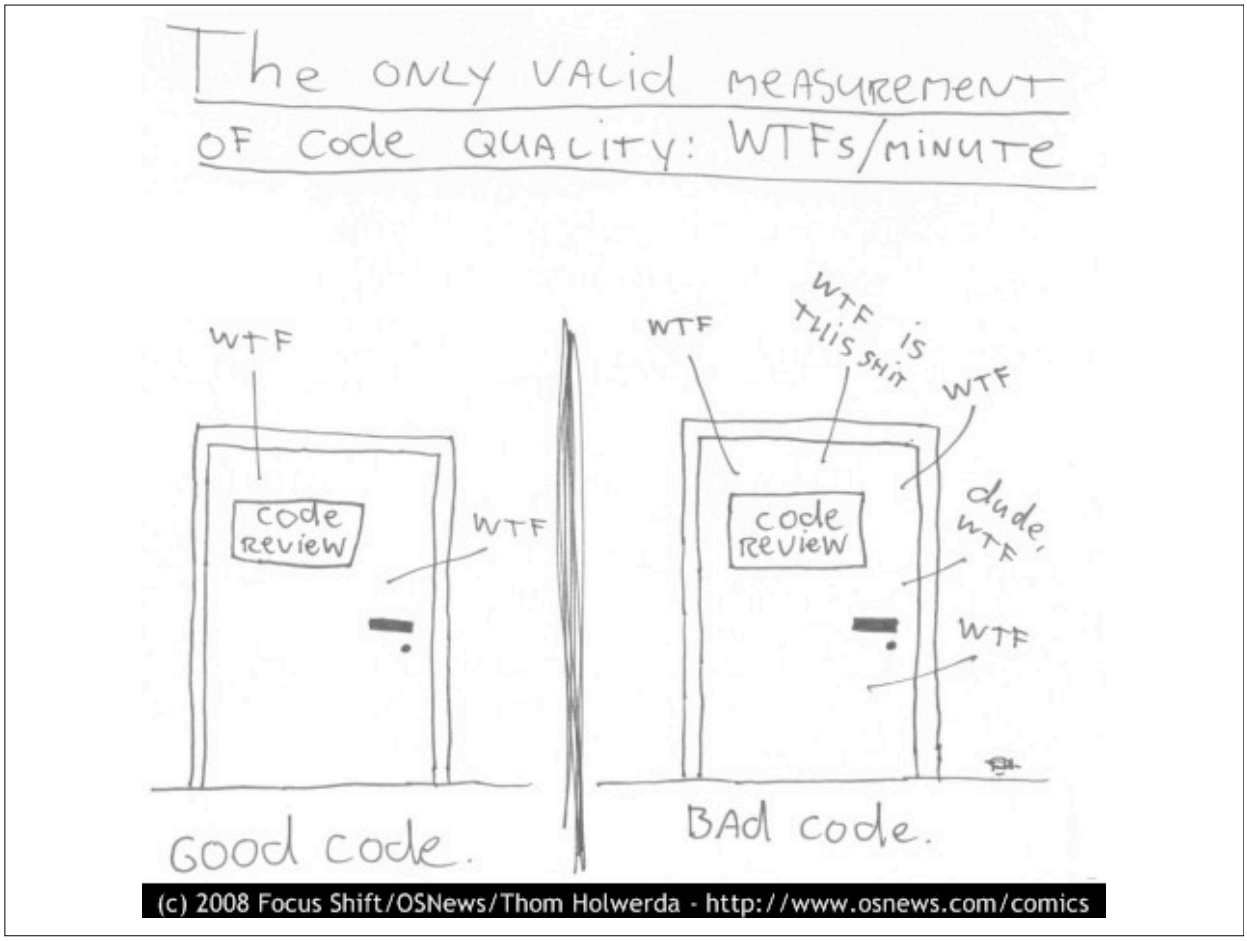
NF

housekeeping

ask questions anytime

download slides from nealford.com →

download samples from **`github.com/nealford`**


The ONLY VALID MEASUREMENT OF CODE QUALITY: WTFs/MINUTE
WTF
code review
WTF
Good code.
WTF
WTF is THIS SHIT
WTF
code review
dude, WTF
WTF
BAD code.
(c) 2008 Focus Shift/OSNews/Thom Holwerda - http://www.osnews.com/comics


external perspective
is the software valuable to its users?

internal perspective

how appropriate is the design?

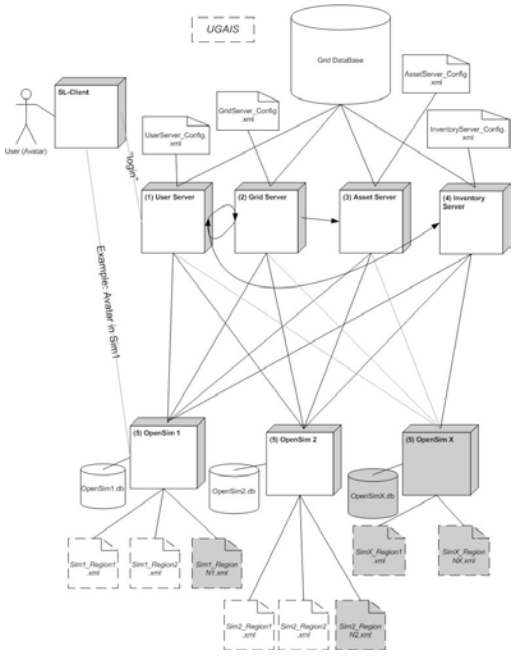
how amenable is emergent design?

how easy is it to understand & extend?

how maintainable is it?

is it salvageable?

30,000 feet

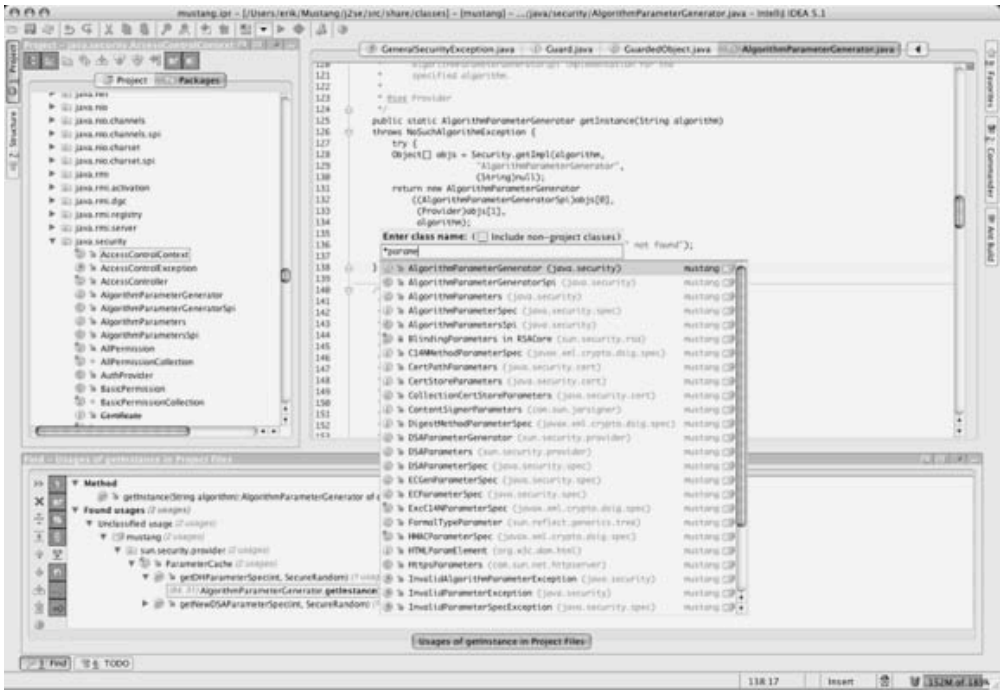


http://opensimulator.org/wiki/Grid_Architecture_Diagram

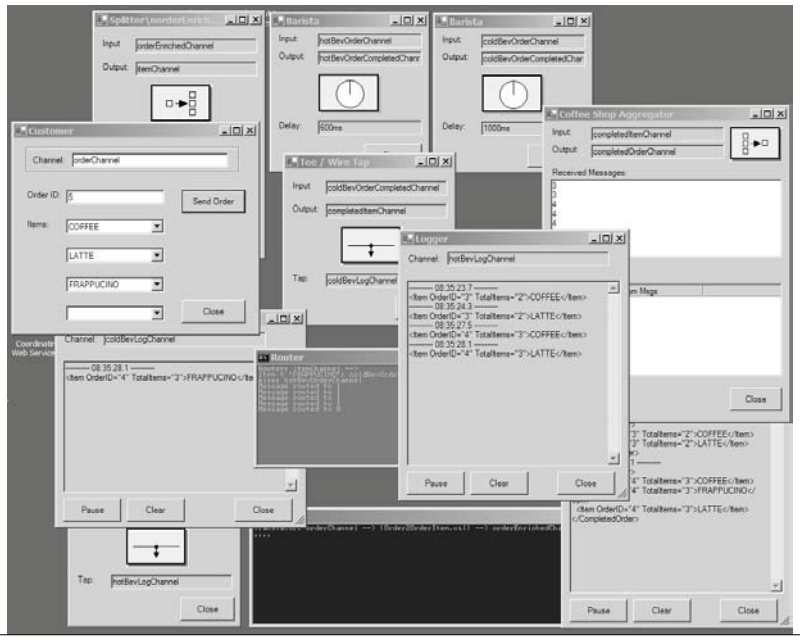
ground level

```
public void mergePluginOutput(BuildDetail build, Map paramete
    Iterator iterator = lines().iterator();
    while (iterator.hasNext()) {
        try {
            assemblePlugin(build, parameters, (String) iterat
        } catch (Exception e) {
            logger.error(e);
            continue;
        }
    }
}

void assemblePlugin(BuildDetail build, Map parameters, String
    String className = line.trim();
    if (className.startsWith("#") || StringUtils.isEmpty(clas
        return;
    }
    Class clazz = Class.forName(className);
    Widget digesterService = (Widget) clazz.newInstance();
    mergeParameters(build, parameters);
    build.addPluginOutput(digesterService.getDisplayName(), c
            .getOutput(parameters));
}

private void mergeParameters(BuildDetail build, Map parameter
    parameters.put(Widget.PARAM_CC_ROOT, configuration.getCCH
```

where are the defects?



which way do the messages flow?



where do the pictures come from?

models created upfront convey a vision but usually don't reflect reality

generating a complete model for large systems is nearly impossible

systems evolve locally, often uncontrolled

the best picture very much depends on the question you are trying to answer

need tools to create ad-hoc models more easily

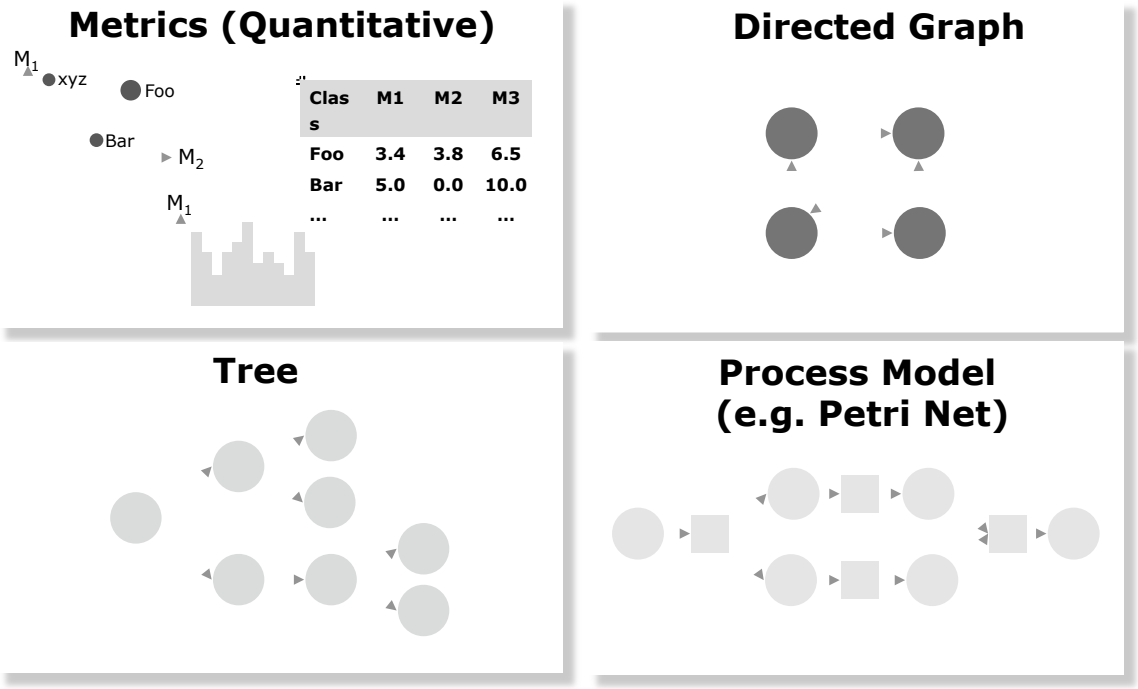
1. select a meta-model

a model that describes a model

example: meta-model for a class diagram

- a class is a box with name, methods, fields,...
- available connectors: association, inheritance, aggregation…
- rules: no circles in inheritance, etc.

common meta-models



2. inspection / instrumentation

static analysis

source code

byte code

dynamic analysis

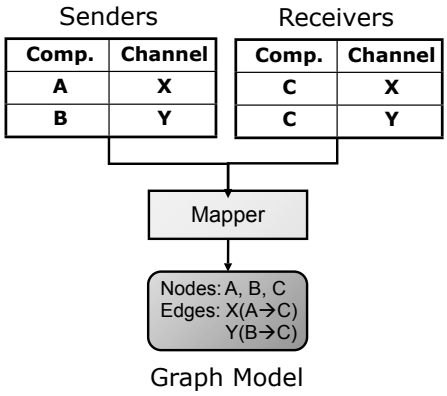
profiling, listen to messages, log files, network sniffer, etc.

3. mapping to the model

example: messaging system

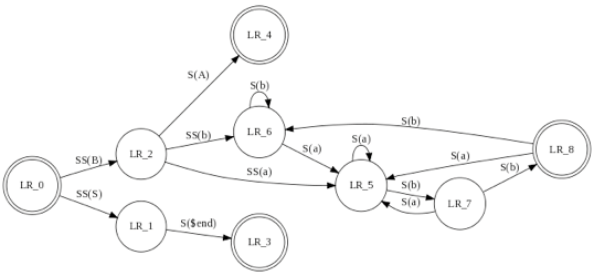
capture send/receive actions

map onto directed graph



4. visualization &...

Graphviz



...validation

don't simply observe

verify & alert

enforce rules or best practices

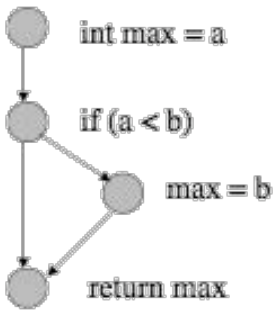
- detect cycles
- islands on a dependency graph

cyclomatic complexity

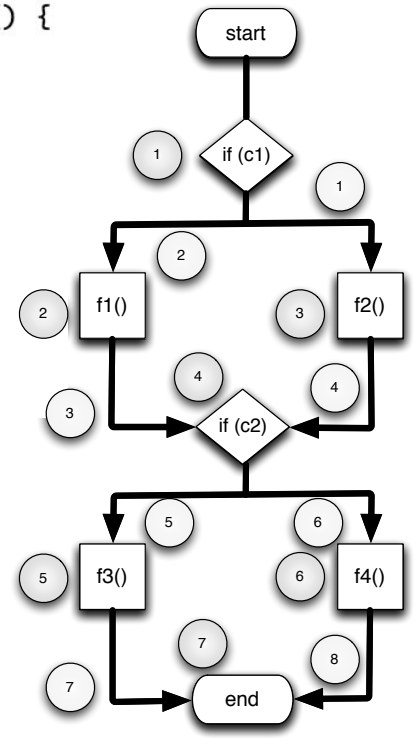
measures complexity of a function

```
V(G)= e - n + 2
V(G) = cyclomatic complexity of G
e= # edges
n= # of nodes
```

```
int max (int a, int b) {
   int max = a;
   if (a < b) {
       max = b;
   }
   return max;
}
```




```
public void doIt() {
    if (c1) {
        f1();
    } else {
        f2();
    }
    if (c2) {
        f3();
    } else {
        f4();
    }
}
```



chidamber & kemerer object-oriented metrics

shyam r chidamber
chris f kemerer

easy but not terribly useful very useful

easy (but trivial)

dit	depth of inheritance tree	# levels of inheritance
noc	number of children	# immediate descendants
npm	number of public methods	# public methods in class

very useful

wmc	weighted methods/ class	∑ of cyclomatic complexity
rfc	response for class	# of methods executed due to method call
lcom	lack of cohesion	∑ of sets of methods not shared via sharing fields
cbo/ ce	efferent couplings	∑ of other classes this class uses (outgoing calls)
ca	afferent couplings	∑ of how many other classes use this class (incoming calls)

source monitor

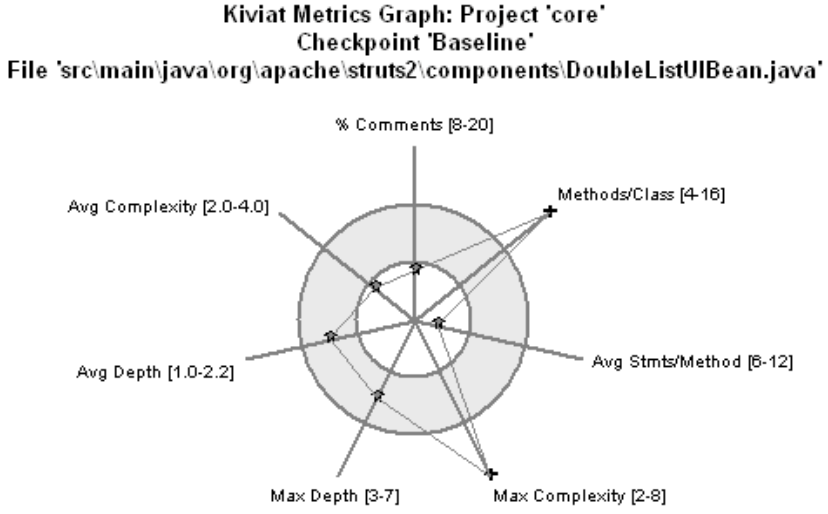
freeware tool for gathering metrics

metrics:

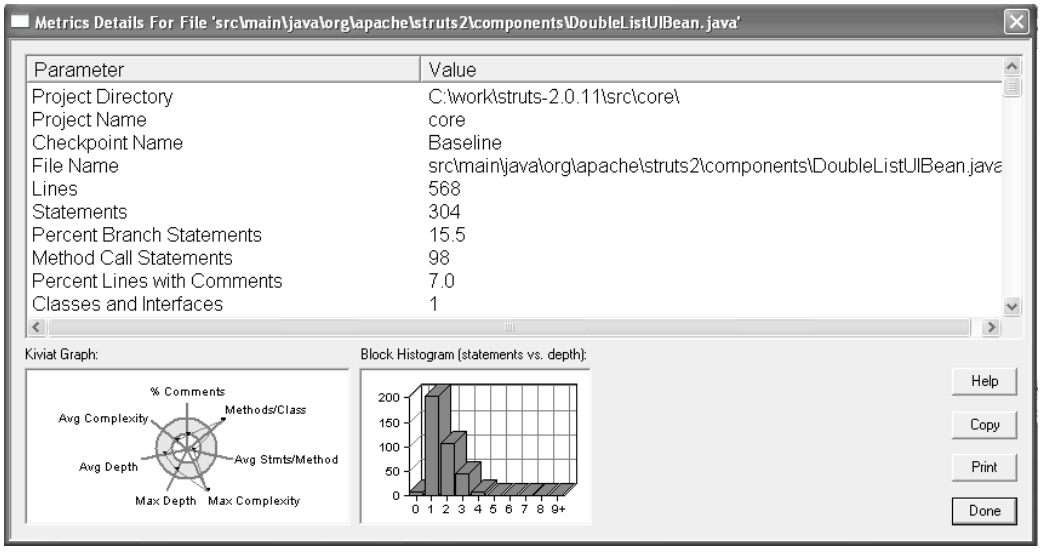
lines, statements, % branches, calls, % comments, classes, methods/class, avg stmts/ method, max complexity, max depth, average depth, average complexity

graphical user interface, windows only!

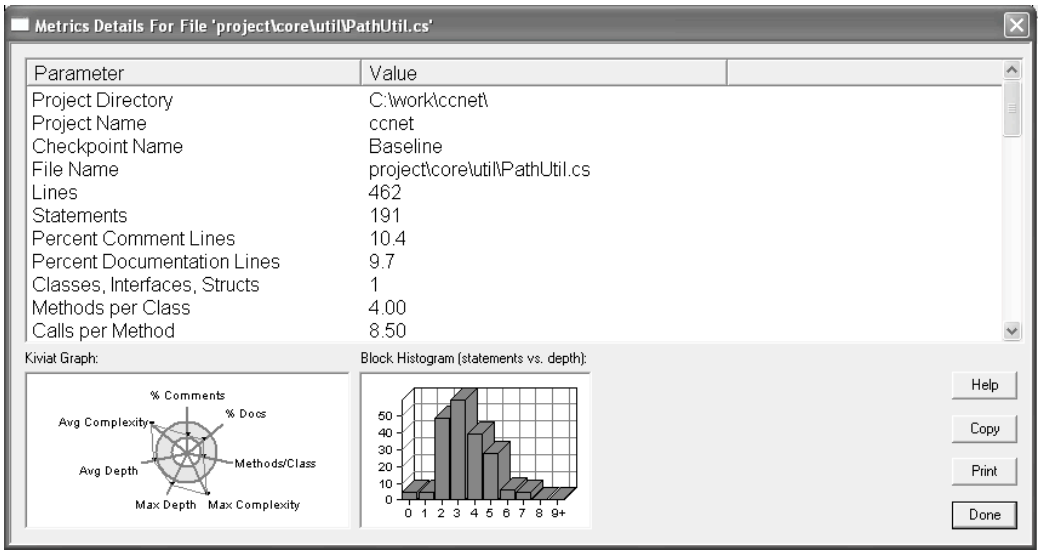
source monitor: kiviat graphs



source monitor: class summary



source monitor w/ c#



looking for...

classes that violate several kiviat graph ranges

really odd shapes

"A project dedicated to making code metrics so widely understood, valuable, and simple that their use becomes ubiquitous, thus raising the quality of software across the industry."

panopticode parts

code coverage with emma

- 1-line change to switch to cobertura

checkstyle

- 1-line switch for custom rule sets

jdepend

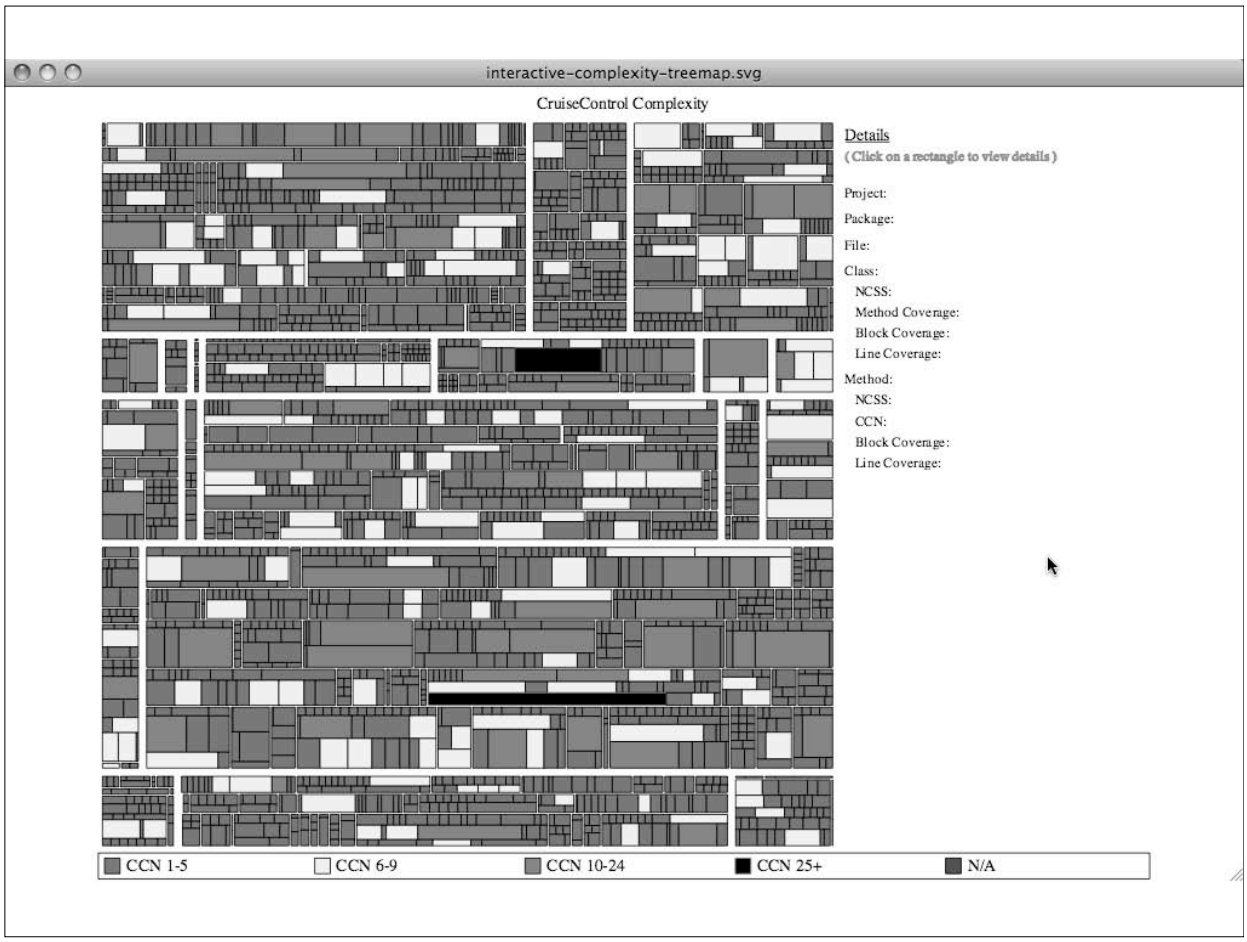
javancss

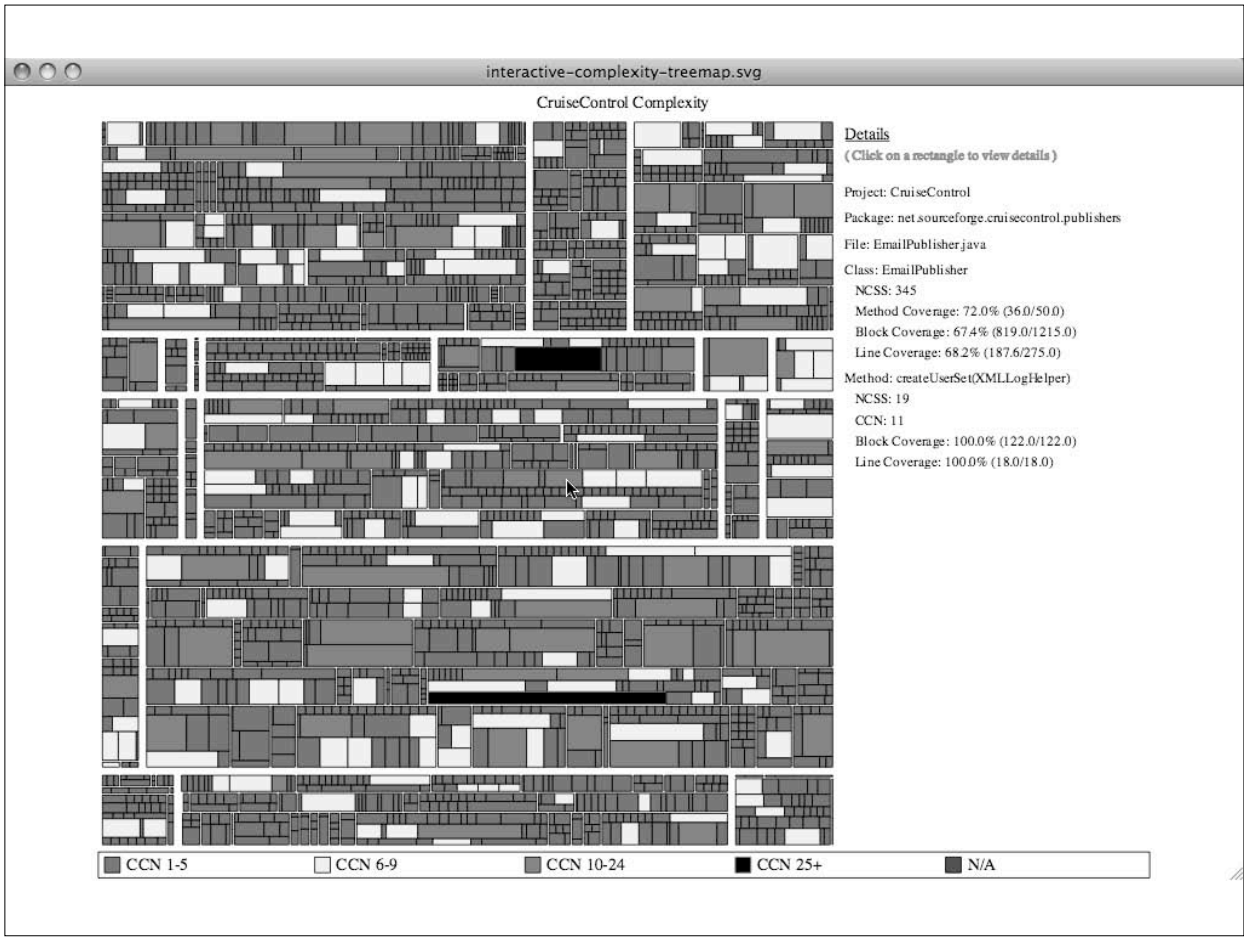
volatility

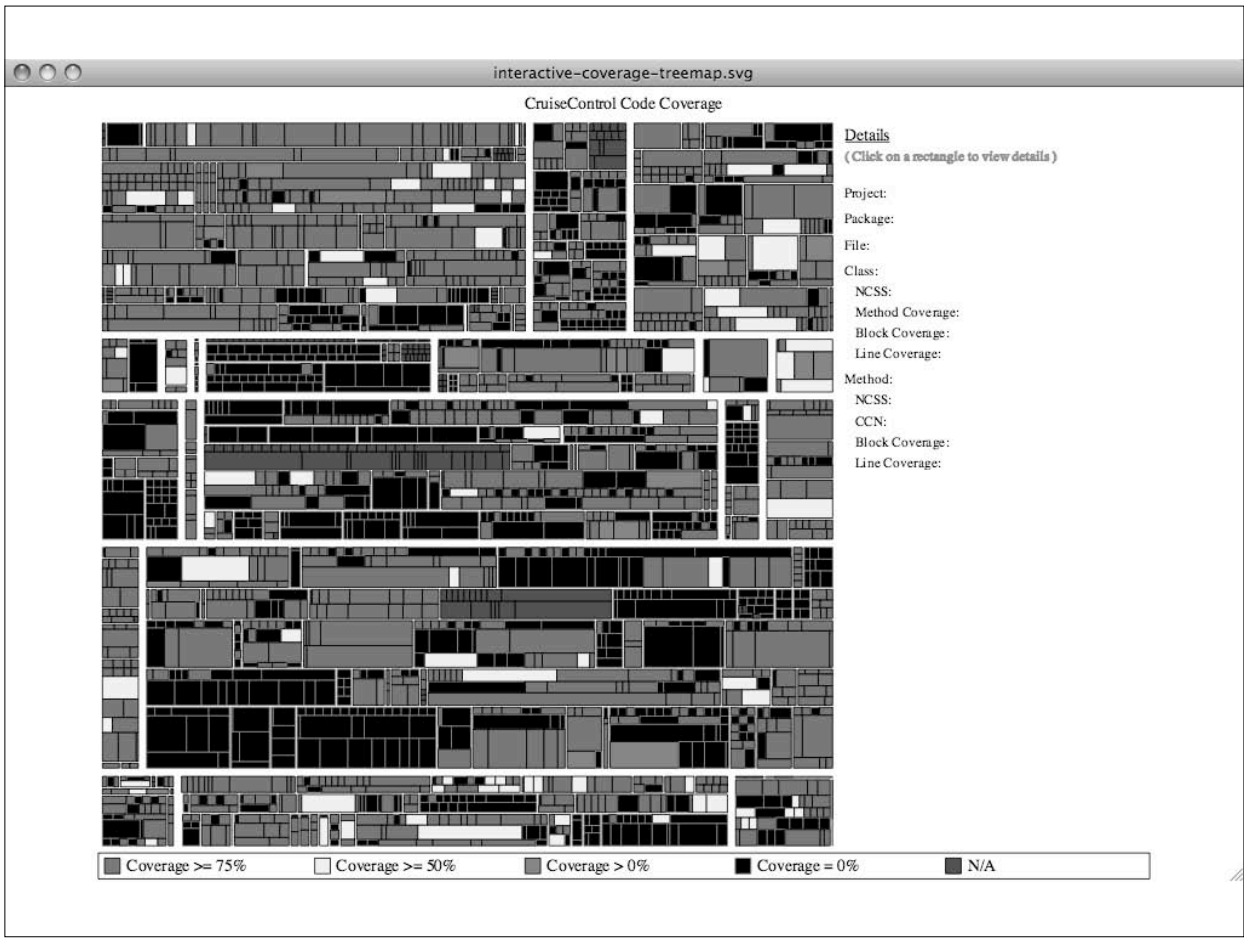
code duplication using simian

aggregator & reports

treemaps




interactive-complexity-treemap.svg
CruiseControl Complexity
Details
(Click on a rectangle to view details)
Project: CruiseControl
Package: net.sourceforge.cruisecontrol.publishers
File: EmailPublisher.java
Class: EmailPublisher
NCSS: 345
Method Coverage: 72.0% (36.0/50.0)
Block Coverage: 67.4% (819.0/1215.0)
Line Coverage: 68.2% (187.6/275.0)
Method: createUserSet(XMLLogHelper)
NCSS: 19
CCN: 11
Block Coverage: 100.0% (122.0/122.0)
Line Coverage: 100.0% (18.0/18.0)
CCN 1-5
CCN 6-9
CCN 10-24
CCN 25+
N/A


interactive-coverage-treemap.svg
CruiseControl Code Coverage
Details
(Click on a rectangle to view details)
Project:
Package:
File:
Class:
NCSS:
Method Coverage:
Block Coverage:
Line Coverage:
Method:
NCSS:
CCN:
Block Coverage:
Line Coverage:
Coverage >= 75%
Coverage >= 50%
Coverage > 0%
Coverage = 0%
N/A

looking for...

20,000 foot view along a single dimension

simple view of one dimension

information radiators

size & complexity pyramid

developed at Universities of Berne and Lugano

shows key metrics and their relationships

allows comparison to “industry standards”

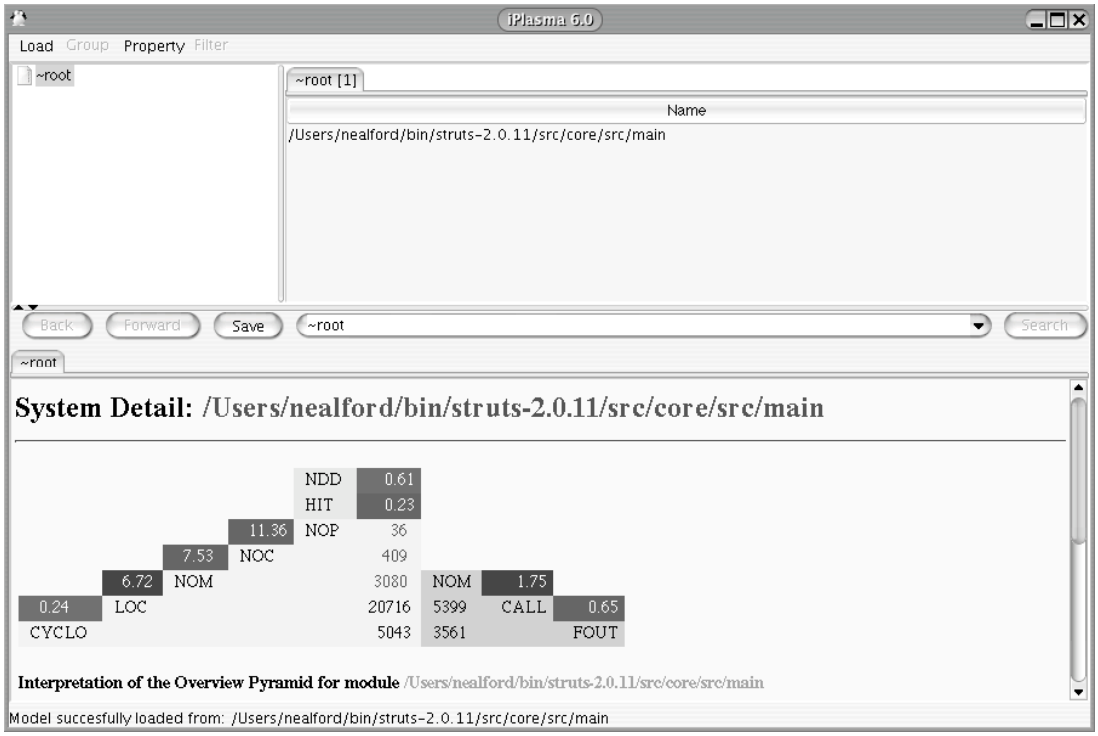
created by iPlasma tool from source code

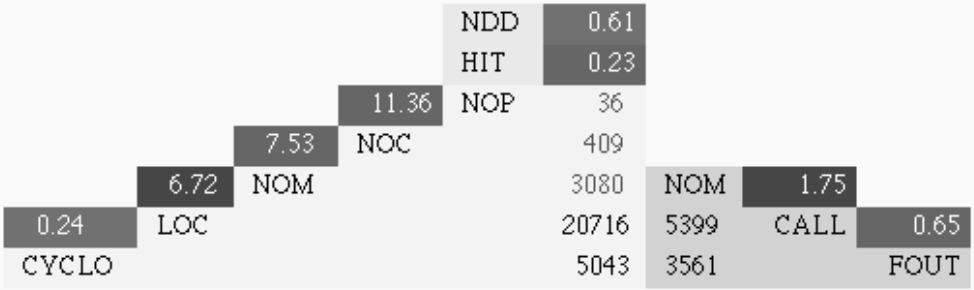
pyramid

		5.75 NOP	224				
		6.13 NOC	1289				
	5.69 NOM		7905	7905	NOM	**2.79**	
0.26 LOC			44988	22039		CALLS	**0.40**
CYCLO			11602	8798			FANOUT

	Low	Medium	High
CYCLO / Line	0.16	0.20	0.24
LOC / method	7	10	13
NOM / class	4	7	10
NOC / package	6	17	26
CALLS / method	2.01	2.62	3.20
FANOUT / call	0.56	0.62	0.68

iPlasma + Struts





Interpretation of the Overview Pyramid for module /Users/nealford/bin/struts-2.0.11/src/core/src/main

Class Hierarchies tend to be of **average height** and **wide**
(i.e. inheritance trees tend to have base-classes with many directly derived sub-classes)

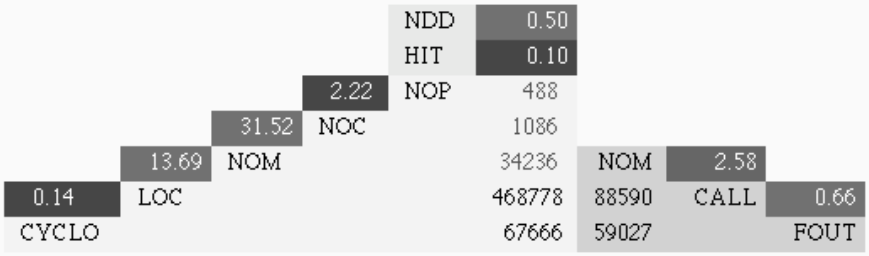
Classes tend to:

- contain an **average** number of methods;
- be organized in **average-sized packages** ;

Methods tend to:

- tend to be rather **short** yet having a rather **complex logic** (i.e. many conditional branches);
- tend to call **few methods** (low coupling intensity) from an **several other classes** ;

vuze



Interpretation of the Overview Pyramid for module
/Users/nealford/Downloads/Applications/Vuze_4.2.0.2_source.zip Folder

Class Hierarchies tend to be **shallow** and **wide**
(i.e. inheritance trees tend to have only few depth-level(s) and base-classes with many directly derived sub-classes)

Classes tend to:

- be rather **large** (i.e. they define many methods);
- be organized in rather **fine-grained packages** (i.e. few classes per package);

Methods tend to:

- tend to be rather **long** yet having a rather **simple logic** (i.e. few conditional branches);
- tend to call an **several methods** from **many other classes** (high coupling dispersion);

looking for...

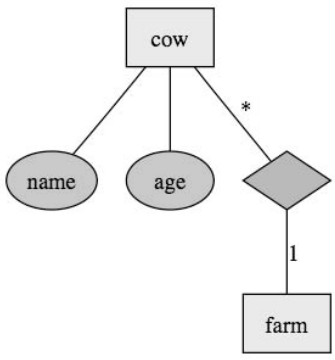
adherence to industry standards

low number of lines / method
(see composed method pattern)

low cyclomatic complexity / line

GraphViz

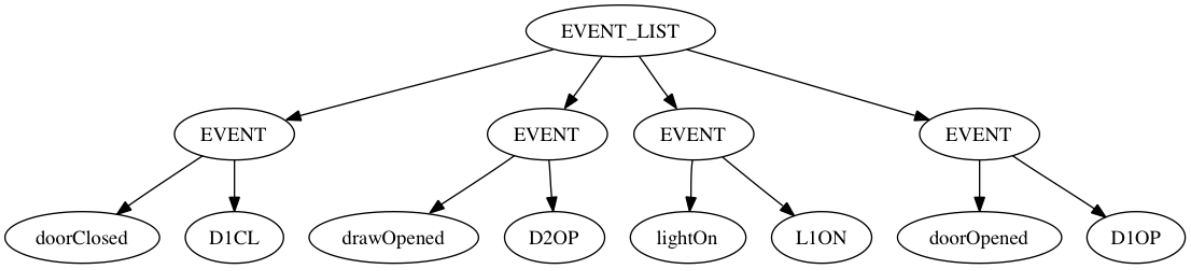
```
graph ER {
  node [shape=box style=filled fillcolor="#00ff005f"];
    farm;
    cow;
  node [shape=ellipse style=filled fillcolor="#ff00005f"];
    {node [label="name"] cow_name;}
    {node [label="age"] cow_age;}
  node [shape=diamond style=filled fillcolor="#0000ff5f"];
    {node [label=""]
      cow_farm;}

  cow -- cow_name;
  cow -- cow_age;

  cow -- cow_farm [label="*"];
  cow_farm -- farm [label="1"];
}
```



eventlist dot file

```
digraph simple {
ordering=out
e1 [label = "EVENT"]
e2 [label = "EVENT"]
e3 [label = "EVENT"]
e4 [label = "EVENT"]
eventList [label = "EVENT_LIST"]
eventList -> e1
eventList -> e2
eventList -> e3
eventList -> e4
c1 [label = "D1CL"]
c2 [label = "D2OP"]
c3 [label = "L1ON"]
c4 [label = "D1OP"]
e1 -> doorClosed
e1 -> c1
e2 -> drawOpened
e2 -> c2
e3 -> lightOn
e3 -> c3
e4 -> doorOpened
e4 -> c4
}
```

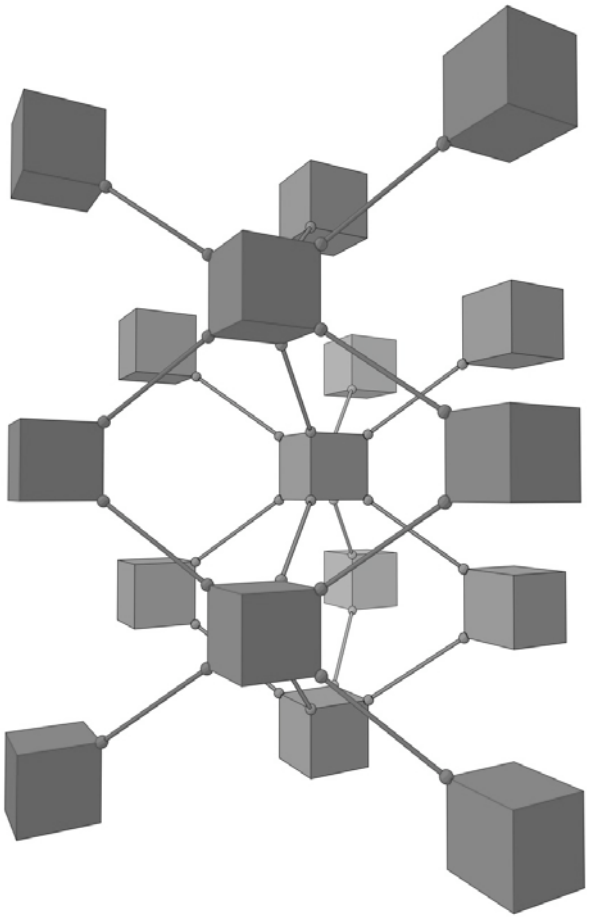
output



generating dot files

```
public void toDot(StringBuilder result) {
  String dotLabel = String.format("{%s", name);
  if (!commands.isEmpty()) {
    dotLabel += "|";
    for(Command c : commands) dotLabel += String.format("%s\\n", c.getName());
  }
  dotLabel += "}";
  result.append(String.format("%s [shape = Mrecord fontsize = 12 label = \"%s\"]\n", name, dotLabel));
  for(Map.Entry<Event,State> e : transitions.entrySet()) {
    result.append(String.format("%s -> %s [ label = \"%s\" fontsize = 10 arrowhead = open];\n",
        name, e.getValue().name, e.getKey().getName()));
  }
}
```

untangling jars



jar analyzer

Kirk Knoernschild
www.kirkk.com

xml output


```
- <JarAnalyzer>
  - <Jars>
    - <Jar name="antlr.jar">
      - <Summary>
        - <Statistics>
            <ClassCount>210</ClassCount>
            <AbstractClassCount>48</AbstractClassCount>
            <PackageCount>10</PackageCount>
            <Level>1</Level>
          </Statistics>
        - <Metrics>
            <Abstractness>0.23</Abstractness>
            <Efferent>0</Efferent>
            <Afferent>1</Afferent>
            <Instability>0.00</Instability>
            <Distance>0.77</Distance>
          </Metrics>
        - <Packages>
            <Package>antlr</Package>
            <Package>antlr.build</Package>
            <Package>antlr.collections</Package>
            <Package>antlr.debug</Package>
            <Package>antlr.preprocessor</Package>
            <Package>antlr.actions.cpp</Package>
            <Package>antlr.actions.csharp</Package>
            <Package>antlr.actions.java</Package>
            <Package>antlr.collections.impl</Package>
            <Package>antlr.debug.misc</Package>
          </Packages>
          <OutgoingDependencies> </OutgoingDependencies>
        - <IncomingDependencies>
            <Jar>struts.jar</Jar>
          </IncomingDependencies>
          <Cycles> </Cycles>
          <UnresolvedDependencies> </UnresolvedDependencies>
        </Summary>
      </Jar>
    - <Jar name="commons-beanutils.jar">
      - <Summary>
        - <Statistics>
            <ClassCount>66</ClassCount>
            <AbstractClassCount>7</AbstractClassCount>
            <PackageCount>4</PackageCount>
            <Level>2</Level>
          </Statistics>
        - <Metrics>
            <Abstractness>0.11</Abstractness>
```


transformed

JarAnalyzer Analysis

Run with JarAnalyzer on

Summary

[summary] [jars] [cycles] [explanations]

Jar Name	Total Classes	Abstract Classes	Packages	Level	Abstractness	Efferent	Afferent	Instability	Distance
antlr.jar	210	48	10	1	0.23	0	1	0.00	0.77
commons-beanutils.jar	66	7	4	2	0.11	2	3	0.40	0.49
commons-collections.jar	187	15	3	1	0.08	0	4	0.00	0.92
commons-digester.jar	55	9	3	3	0.16	3	2	0.60	0.24
commons-fileupload.jar	16	4	1	1	0.25	0	1	0.00	0.75
commons-logging.jar	18	2	2	1	0.11	0	4	0.00	0.89
commons-validator.jar	30	1	2	4	0.03	5	1	0.83	0.14
jakarta-oro.jar	62	13	6	1	0.21	0	1	0.00	0.79
struts.jar	289	33	25	5	0.11	7	0	1.00	0.11

Jars

[summary] [jars] [cycles] [explanations]

antlr.jar

Level: 1 Afferent Couplings: 1 Efferent Couplings: 0 Abstractness: 0.23 Instability: 0.00 Distance: 0.77

Uses Jars	Used by Jars	Cycles With
None	struts.jar	*None*

Packages within jar	Unresolved Packages
antlr antlr.build antlr.collections antlr.debug antlr.preprocessor antlr.actions.cpp antlr.actions.csharp antlr.actions.java antlr.collections.impl antlr.debug.misc	*None*

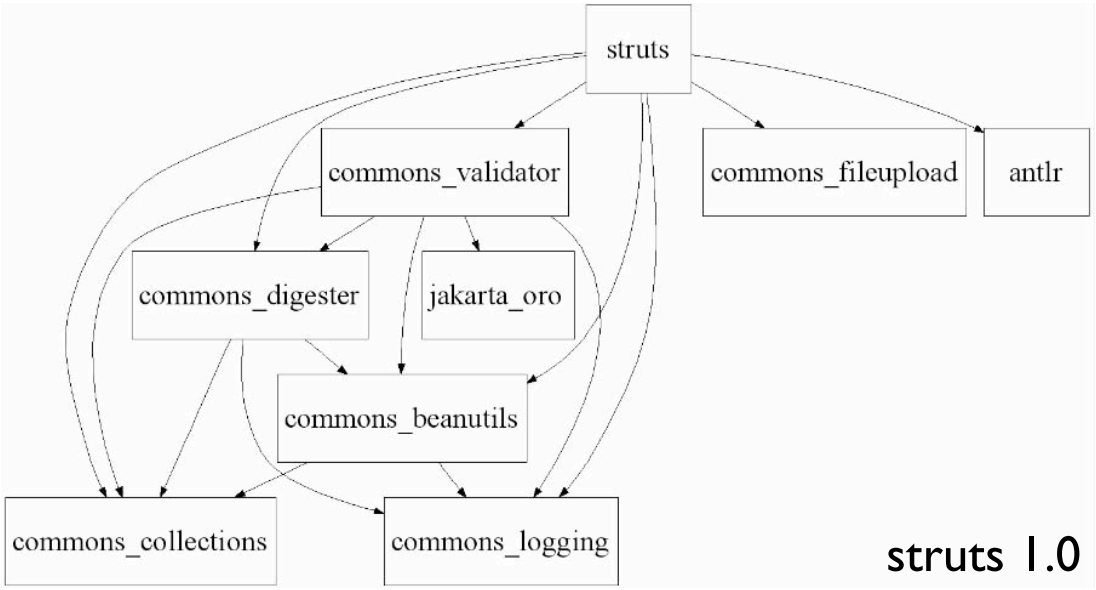
commons-beanutils.jar

Level: 2 Afferent Couplings: 3 Efferent Couplings: 2 Abstractness: 0.11 Instability: 0.40 Distance: 0.49

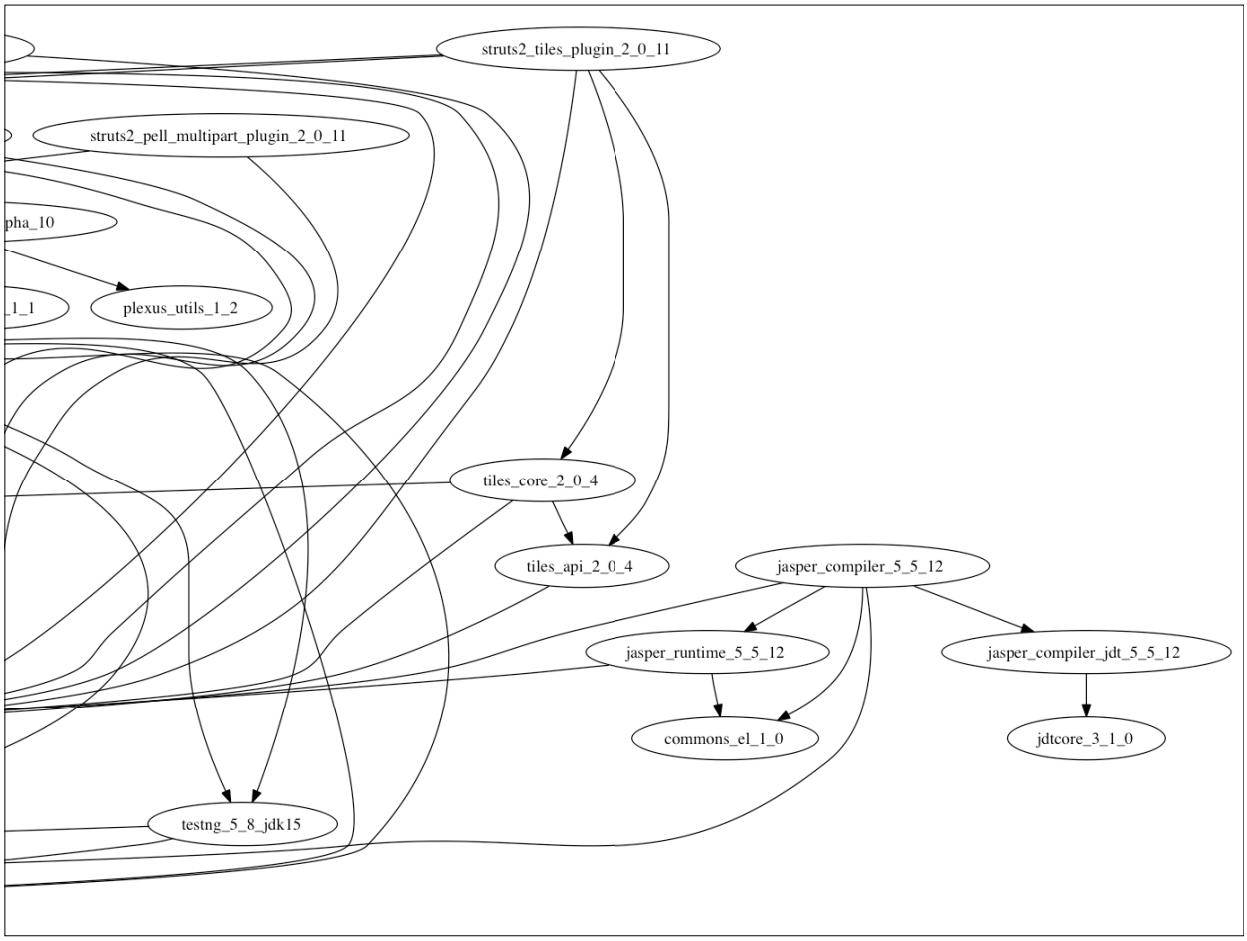
Uses Jars	Used by Jars	Cycles With
commons-collections.jar commons-logging.jar	commons-digester.jar commons-validator.jar struts.jar	*None*

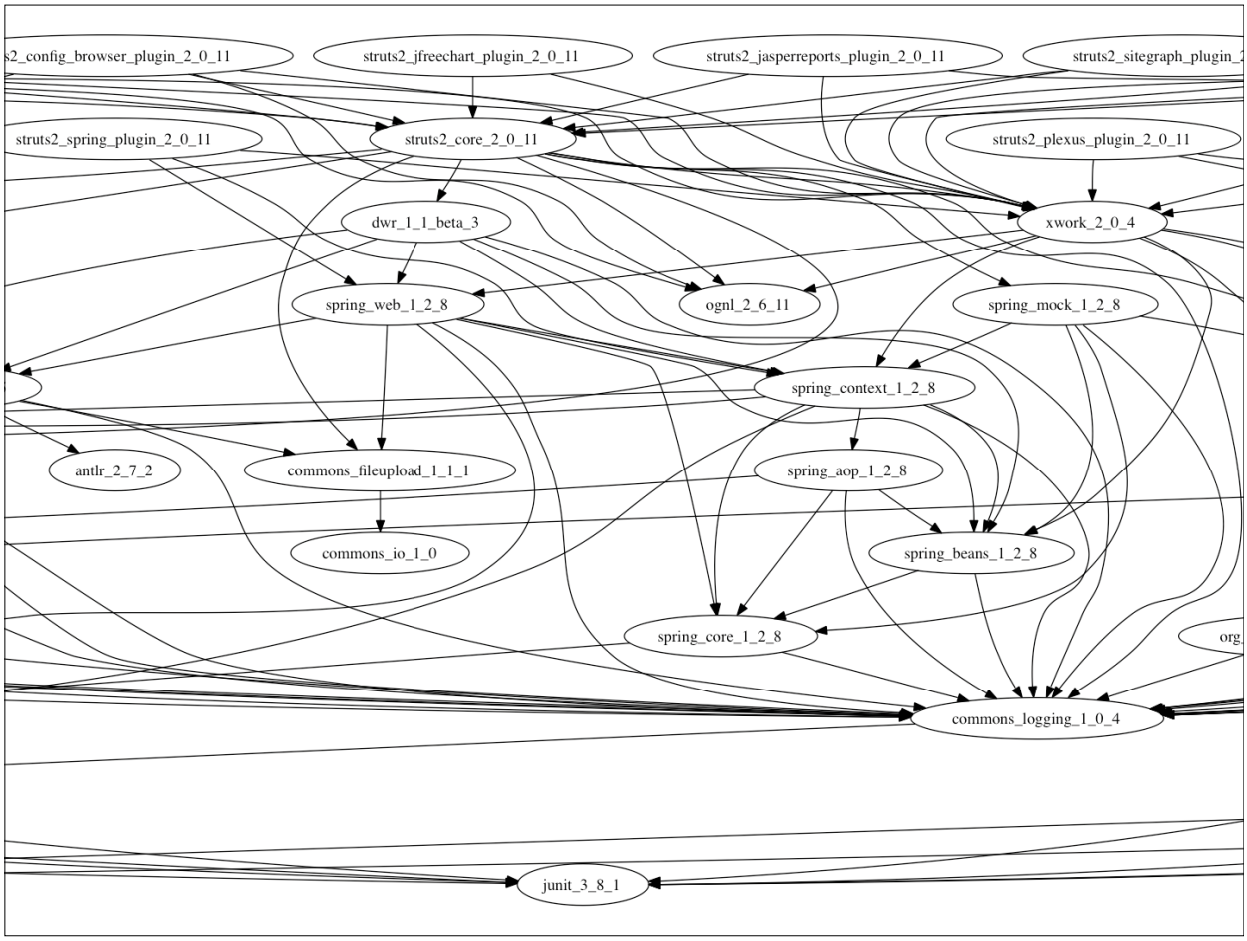
Packages within jar	Unresolved Packages
org.apache.commons.beanutils.converters org.apache.commons.beanutils org.apache.commons.beanutils.locale.converters org.apache.commons.beanutils.locale	*None*

graphical



struts 1.0





looking for...

not that!

small number of one-way dependencies

no “rats’ nests”

no cycles

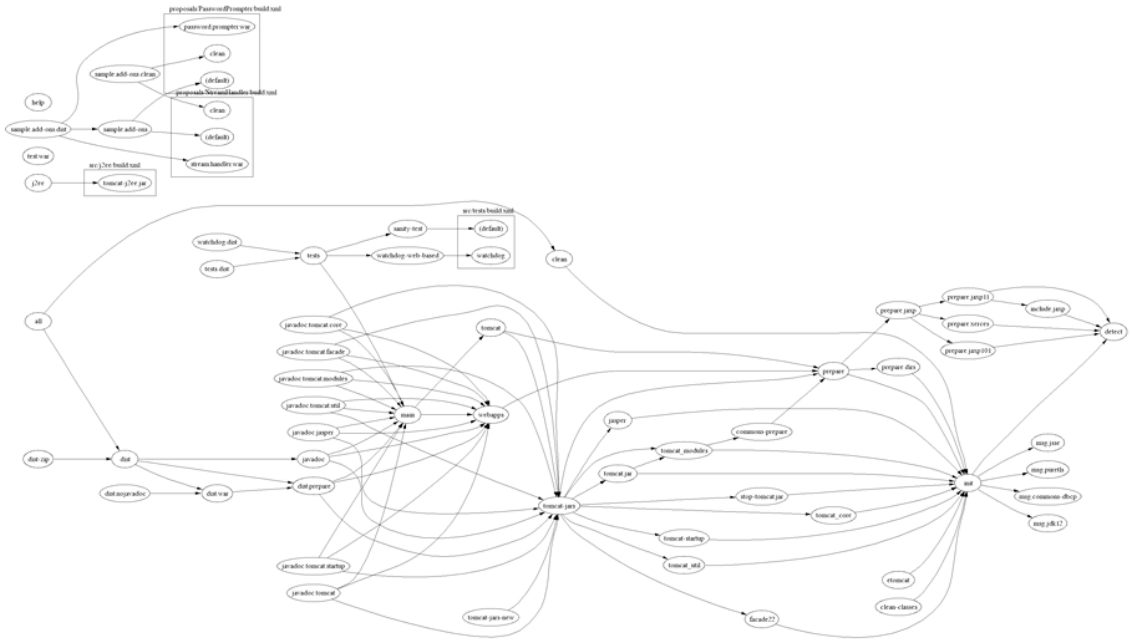

Vizant
ant task to create a GraphViz
DOT file from an ant build file
http://vizant.sourceforge.net/

ant 1.5

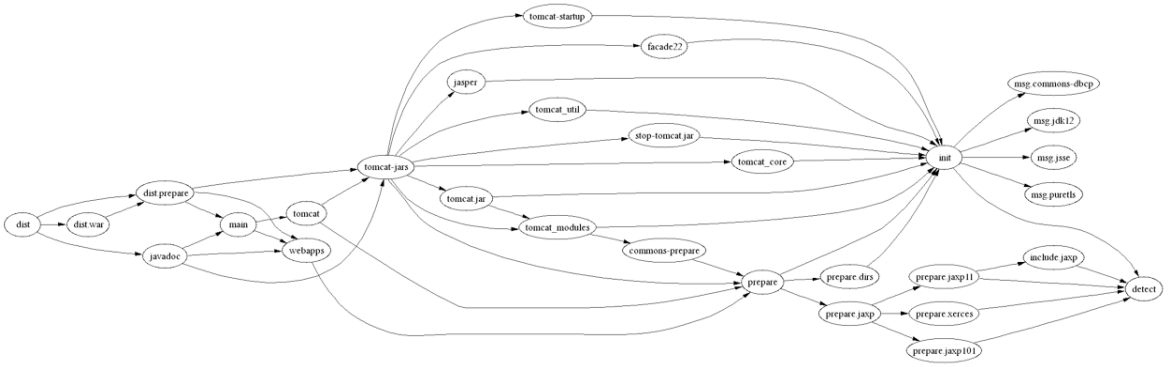

allclean
clean
dist
install
internal_dist
dist_javadocs
javadocs
javadoc_check
main
bootstrap
dist-lite
jars
install-lite
distribution
main_distribution
build
prepare
interactive-tests
compile-tests
run-single-test
run-which
check_for_optional_packages
src-dist
dump-info
dump-sys-properties
xml-check
test
run-tests
probe-offline

log4j

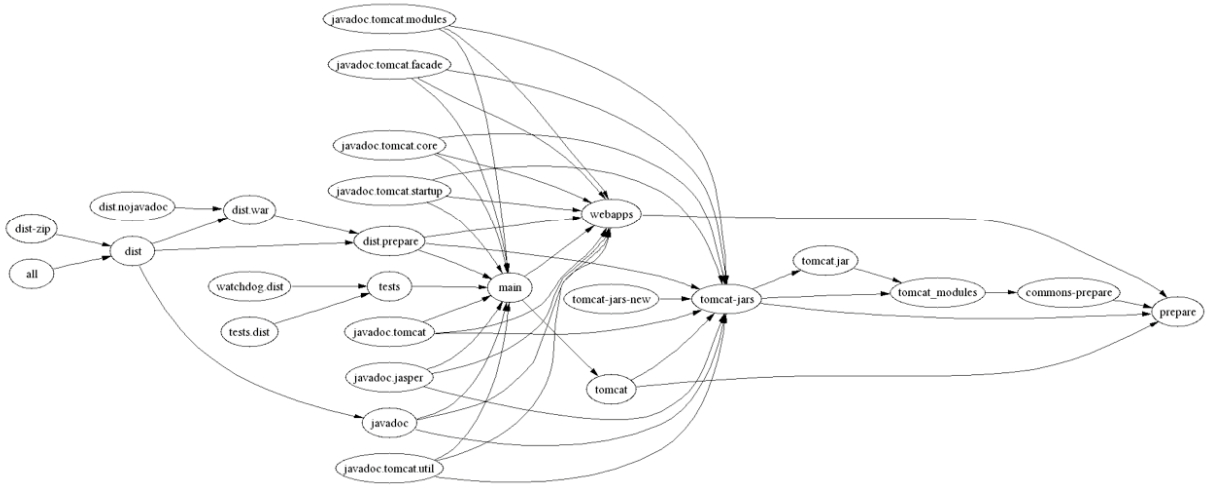
tomcat 3.3.1



from="dist"



to="prepare"



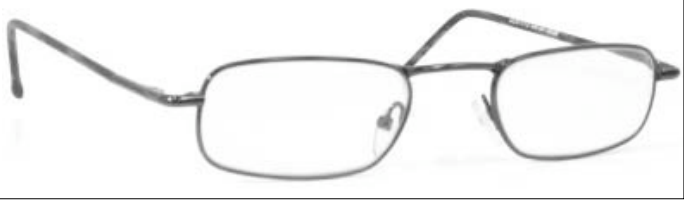
look for...

hot spots

more even distribution

networks around common dependent elements

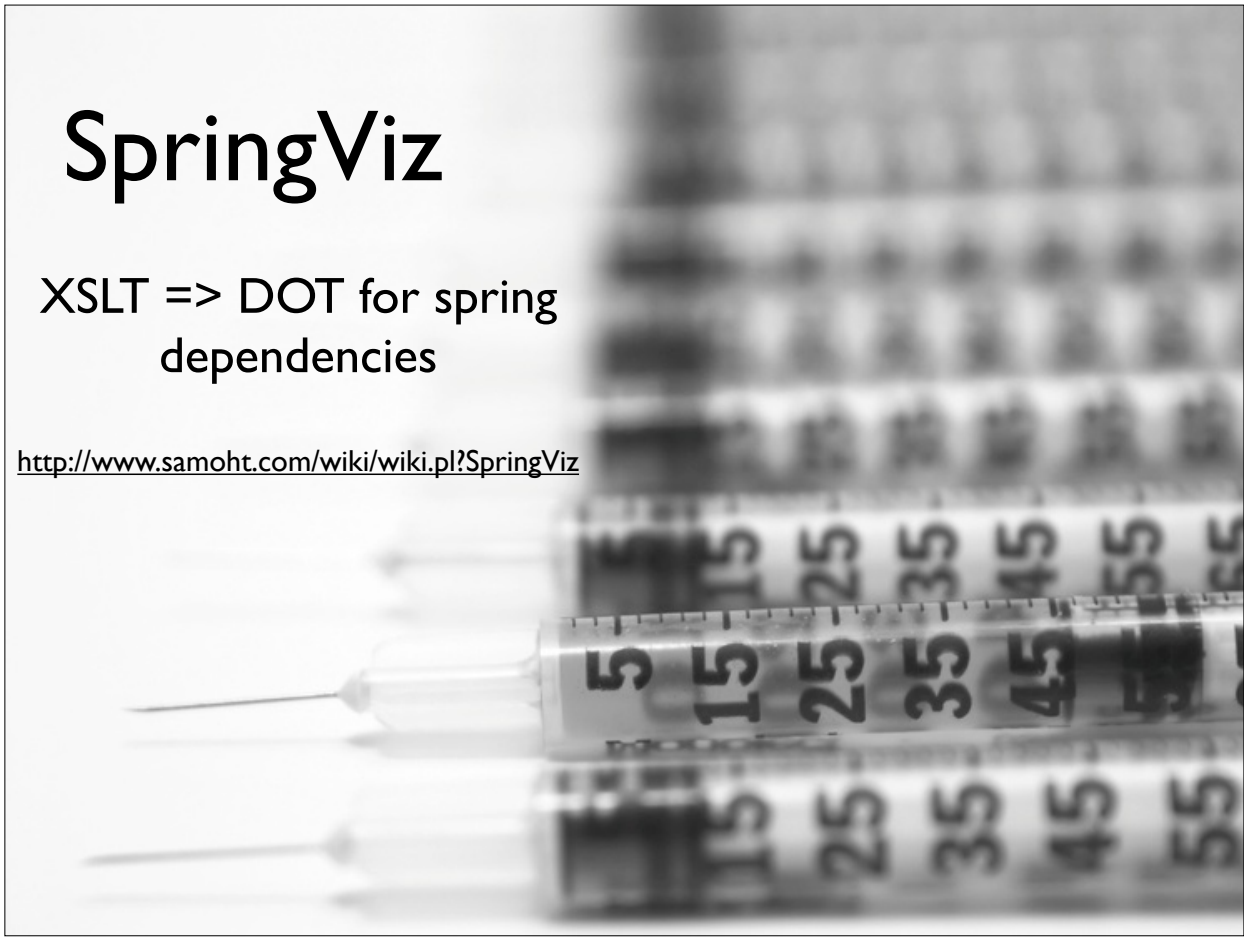
think about extracting
via macrodef

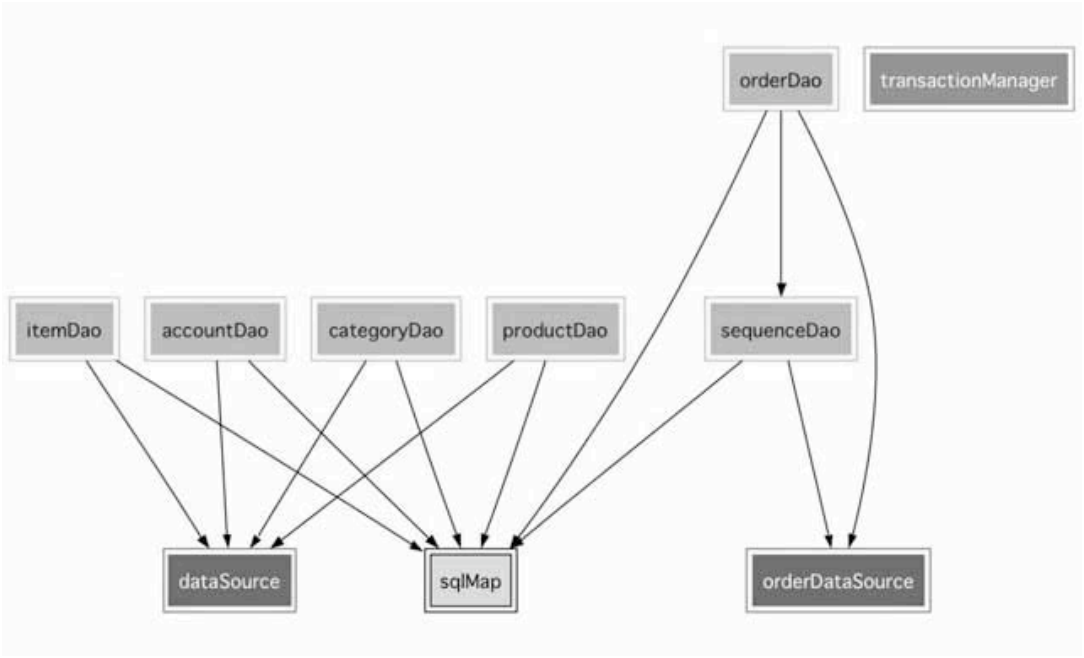


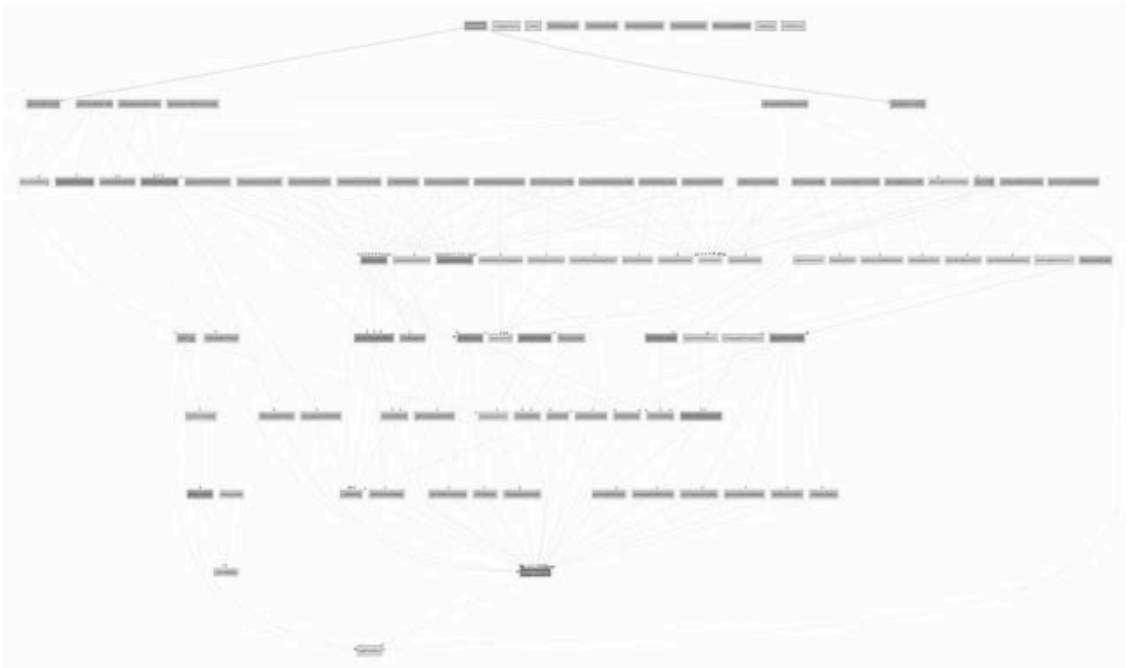
SpringViz

XSLT => DOT for spring
dependencies

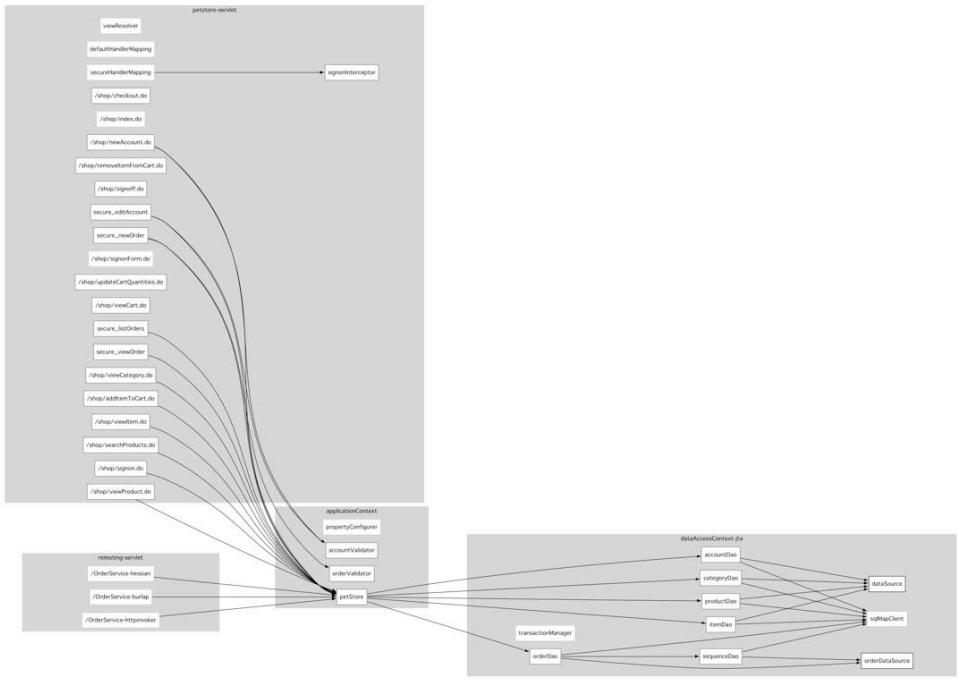
http://www.samoht.com/wiki/wiki.pl?SpringViz




orderDao
transactionManager
itemDao
accountDao
categoryDao
productDao
sequenceDao
dataSource
sqlMap
orderDataSource



SpringViz



look for...

regularity

symmetry

overloaded dependencies

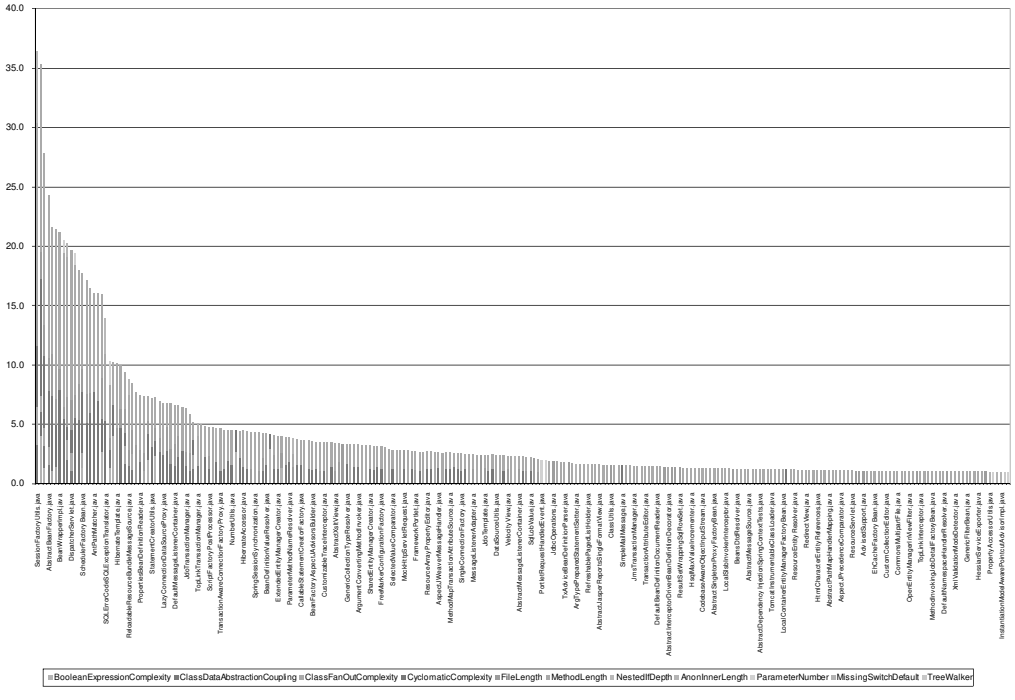
isolated pockets

toxicity chart

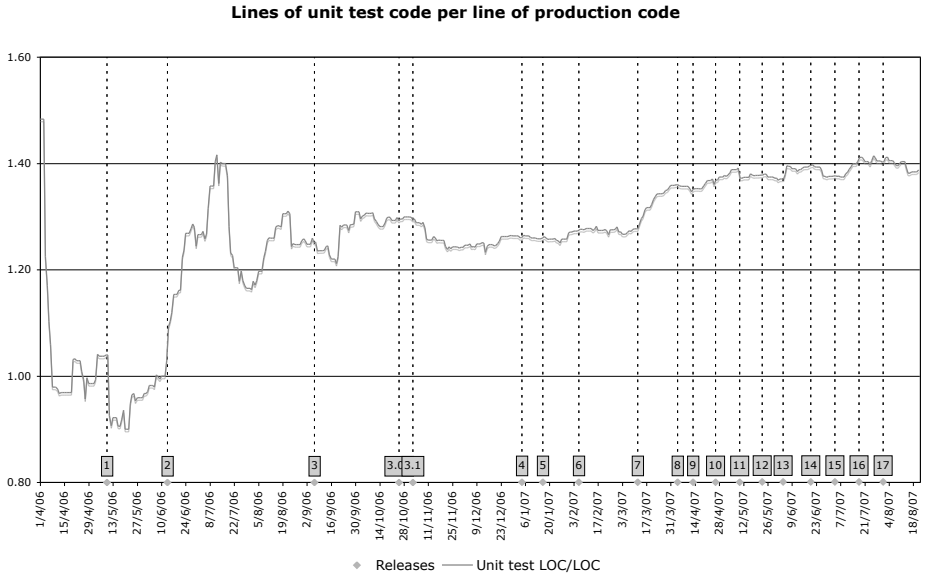
provides easy to compare overview of quality

created with checkstyle + excel

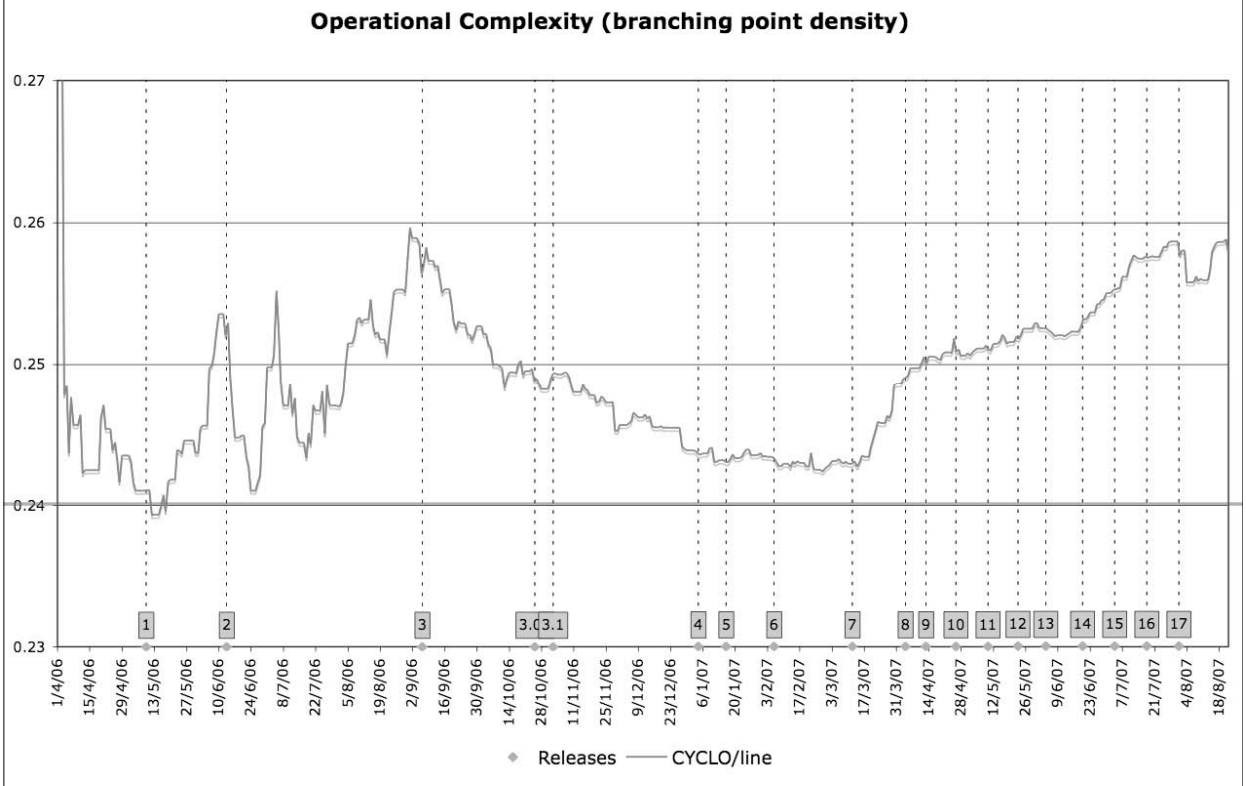
toxicity chart



test to code ratio



created using unix tools + excel



look for...

notifications along your key dimension

toxicity: high-spikes

test-to-code ratio: higher is better

complexity / loc: trends

deltas more interesting than raw numbers

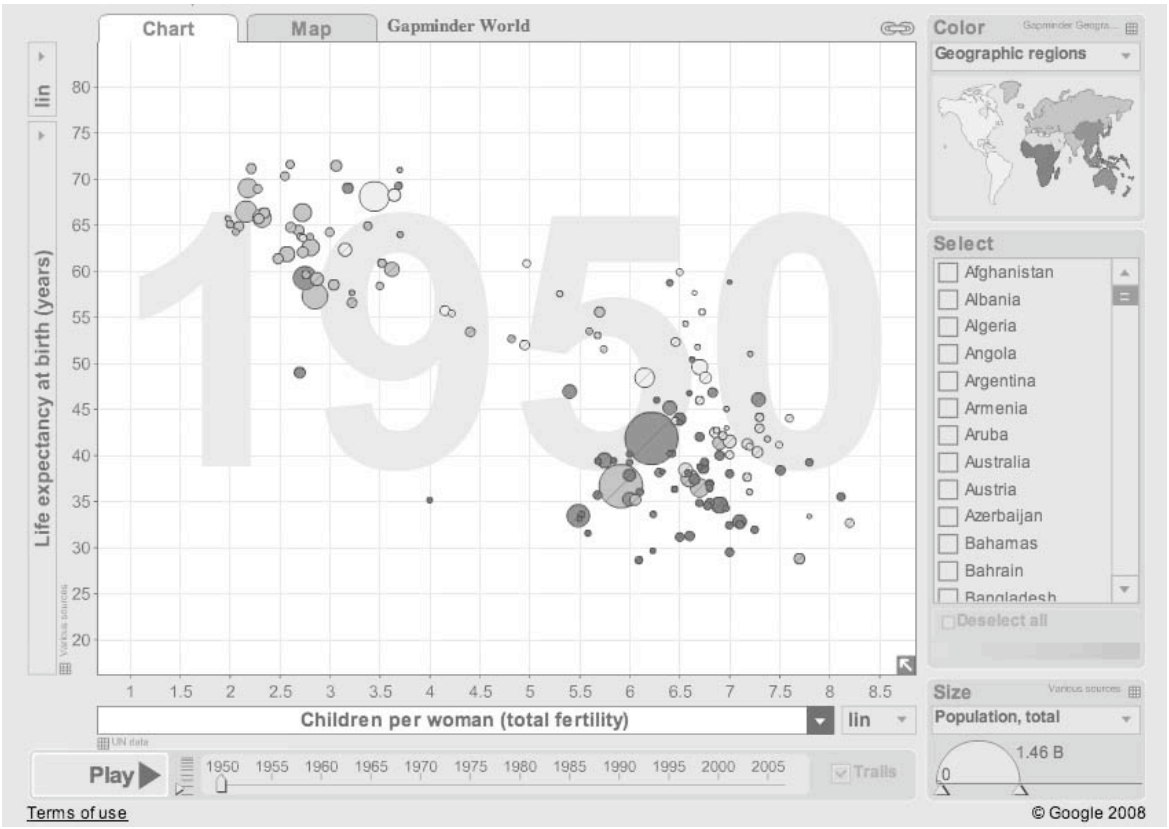
GAPMINDER

"Unveiling the beauty of statistics for a fact based world view."

time-based statistical view of chart data

founded in Stockholm by Ola Rosling, Anna Rosling Rönnlund and Hans Rosling

now realized in the google spreadsheet motion gadget



the data

	Version		loc/cc	LOC	CC
2	v1	1999	6.02941176470588	12915	2142
3	v2	2000	6.17486583184258	13807	2236
4	v3	2001	6.17706949977866	13954	2259
5	v4	2002	6.16593886462882	14120	2290
6	v5	2003	6.29637618636756	14595	2318
7	v6	2004	6.22636327971754	15871	2549
8	v7	2005	6.22466281310212	16153	2595
9	v8	2006	6.20398773006135	16180	2608
10	v9	2007	6.17825921702775	16255	2631
11	v10	2008	6.21148725751236	16330	2629

motion chart gadget

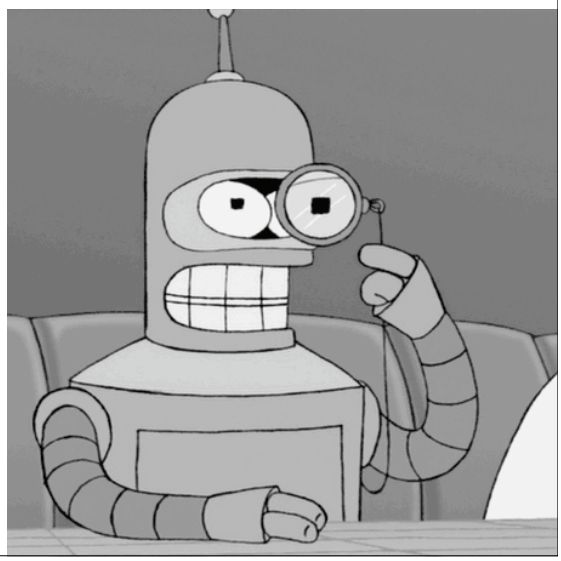
look for...

time-based trends

odd outliers along dimensions

symmetry

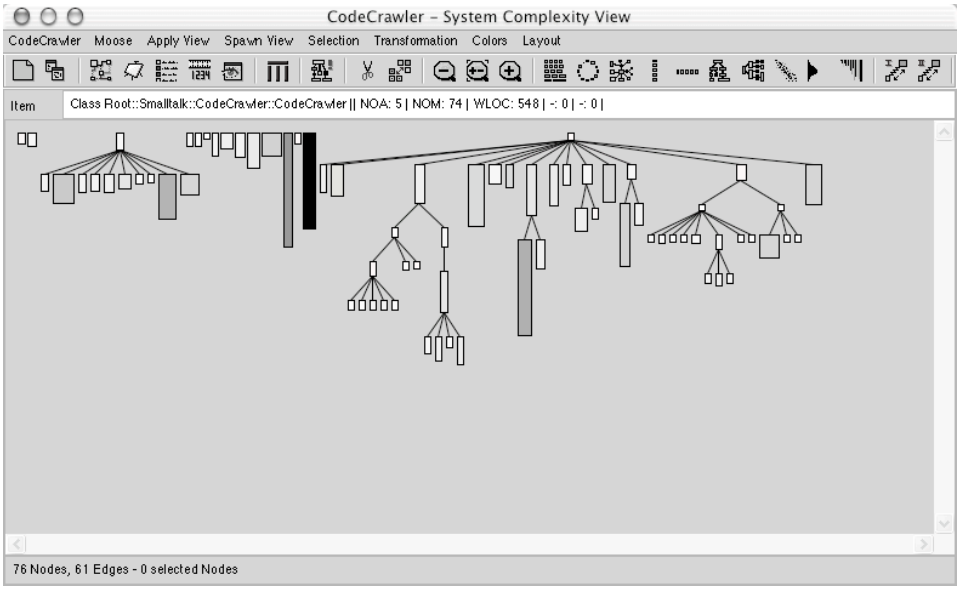
fluidity



CodeCrawler

www.inf.unisi.ch/faculty/lanza/codecrawler.html

CodeCrawler



CodeCrawler

academic graphical metrics tool

language independent

written in VisualAge Smalltalk

based on the Moose platform

quirky but powerful

x-ray

graduate student project written by Jacopo Malnati (http://atelier.inf.unisi.ch/~malnatij/xray.php)

open-source software visualization plug-in for eclipse

provides system complexity view, class & package dependency view

model of the underlying Java project can be triggered and used by other plug-ins

x-ray visualizing itself through via system complexity view

using x-ray

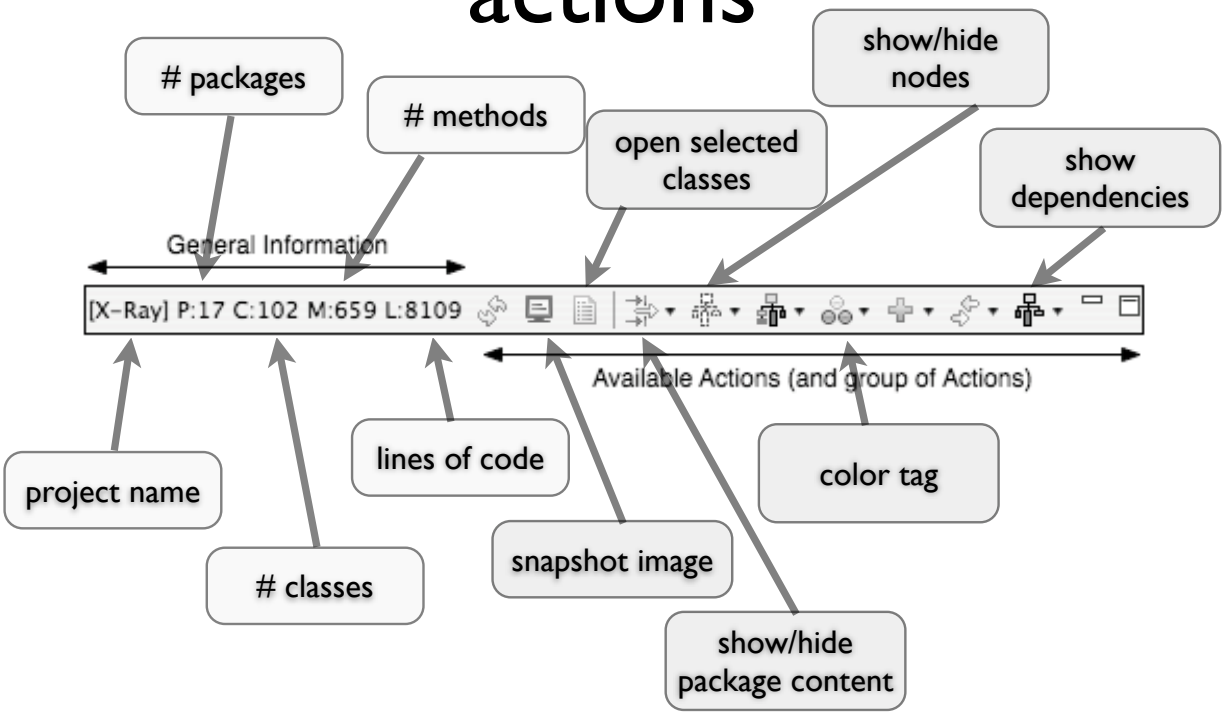
install the plug-in

choose the Analyze Current Project action
from the package explorer

x-ray creates *textual information* and *actions*

visualizations characterized by entities
positioned according to layouts and criterions

actions



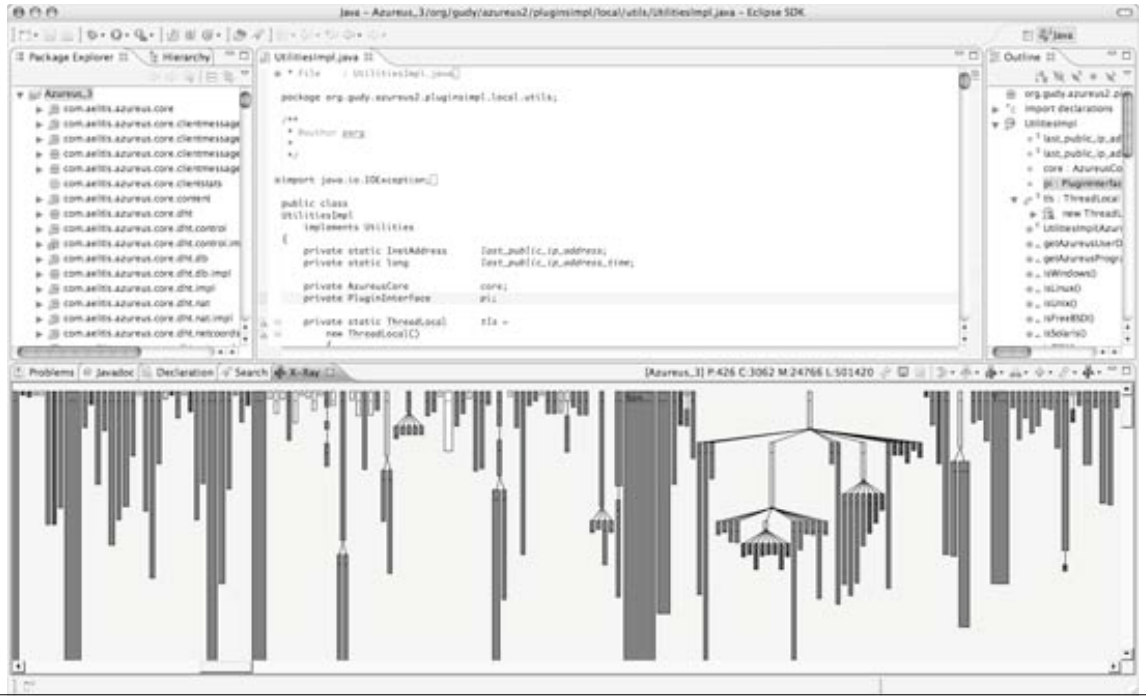
polymetric views

 system complexity view

 class dependency view

 package dependency view

system complexity view



system complexity view

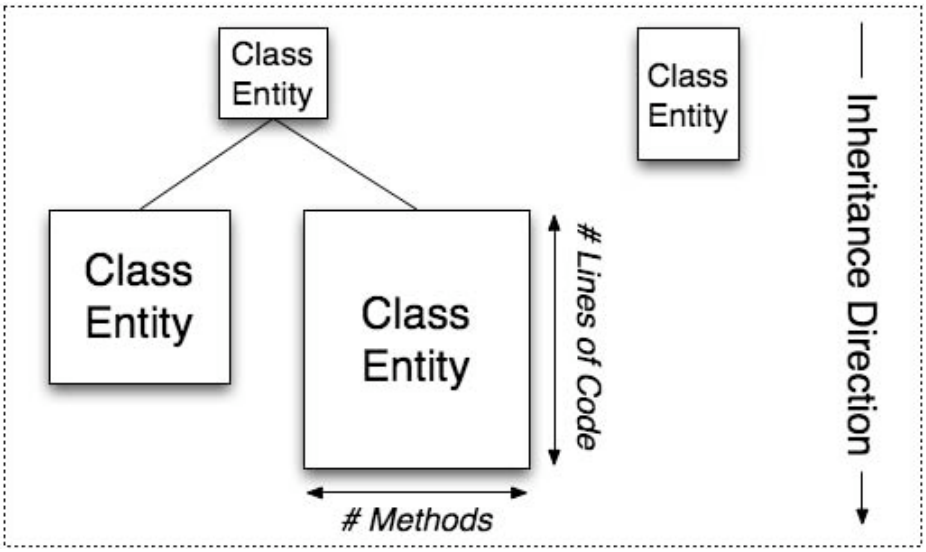
tries to illustrate disharmonies in the design and implementation of a system.

identify big nodes (compared to the others)

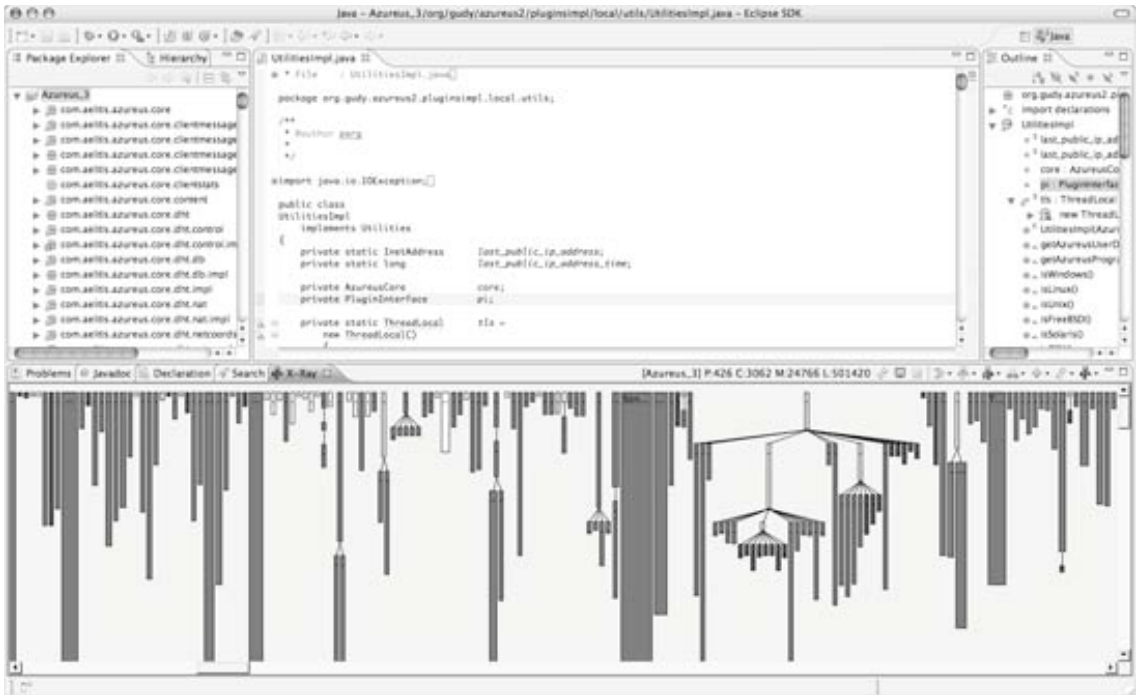
anomalies of shape (provided by the inheritance tree)

view provides several different dimensions of metrics

positional metrics



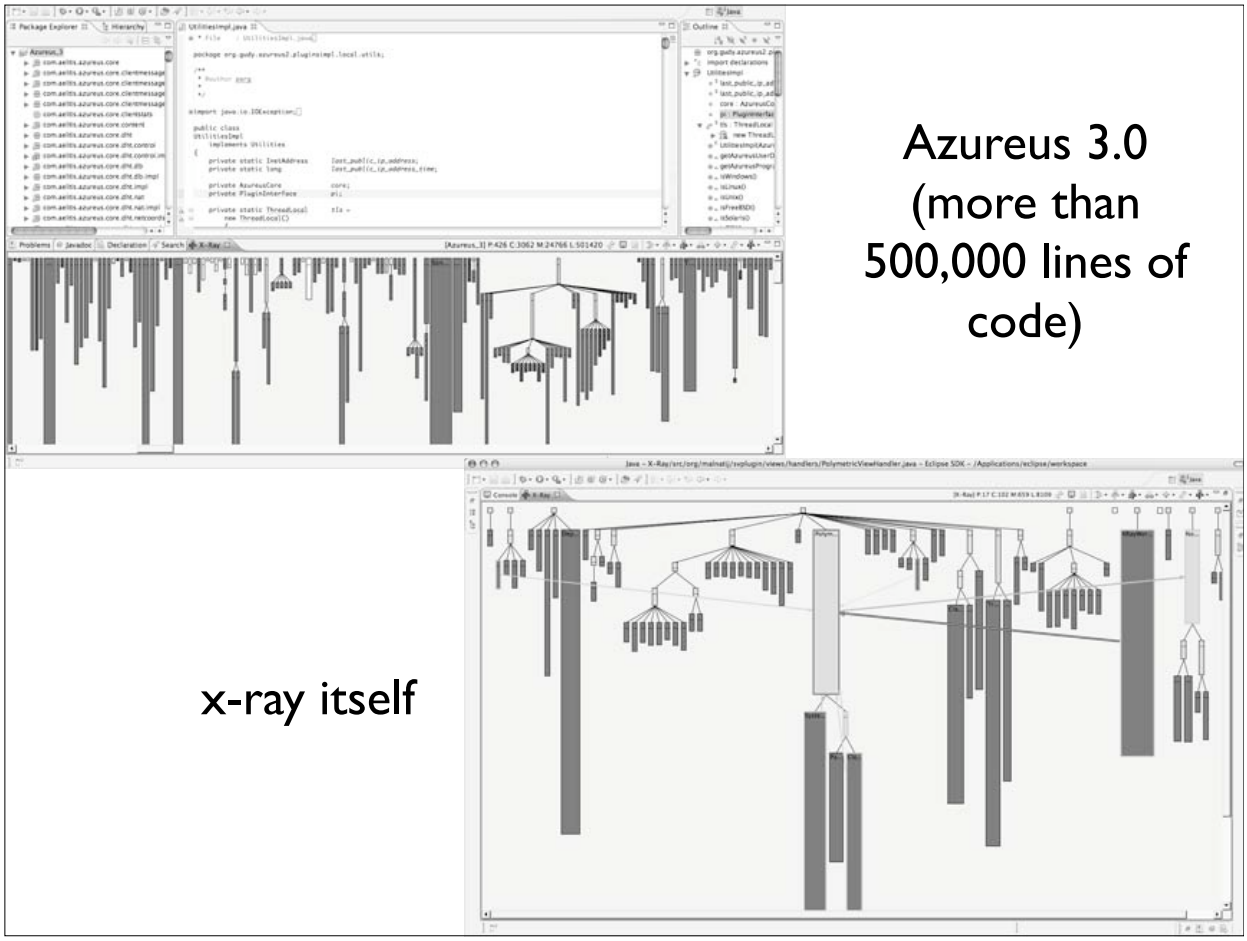
system complexity view



color metrics

- **Dark Blue** implies a concrete class.
- **Light Blue** implies an abstract class.
- **White** implies an interface.
- **Green** implies an external class. By external class we mean a class that is external to the project, while some internal classes are inheriting from it.
- **Light Gray** implies an abstract inner class.
- **Dark Gray** implies a concrete inner class.

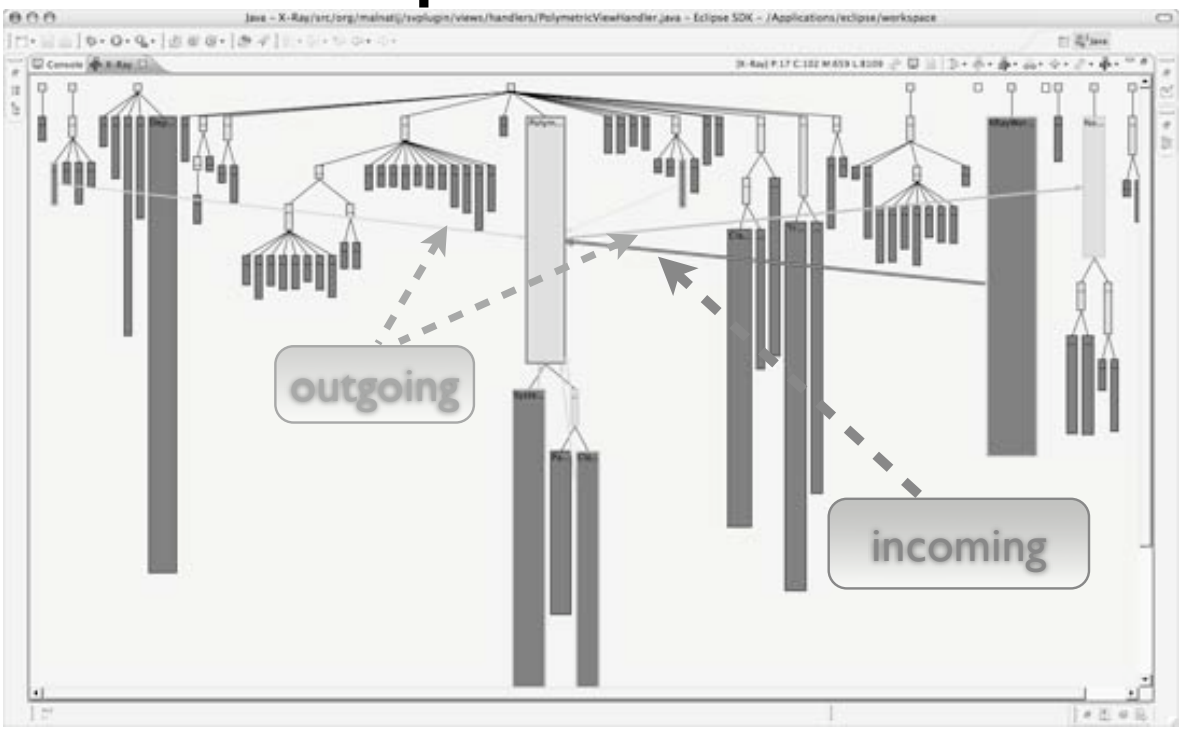
system complexity view



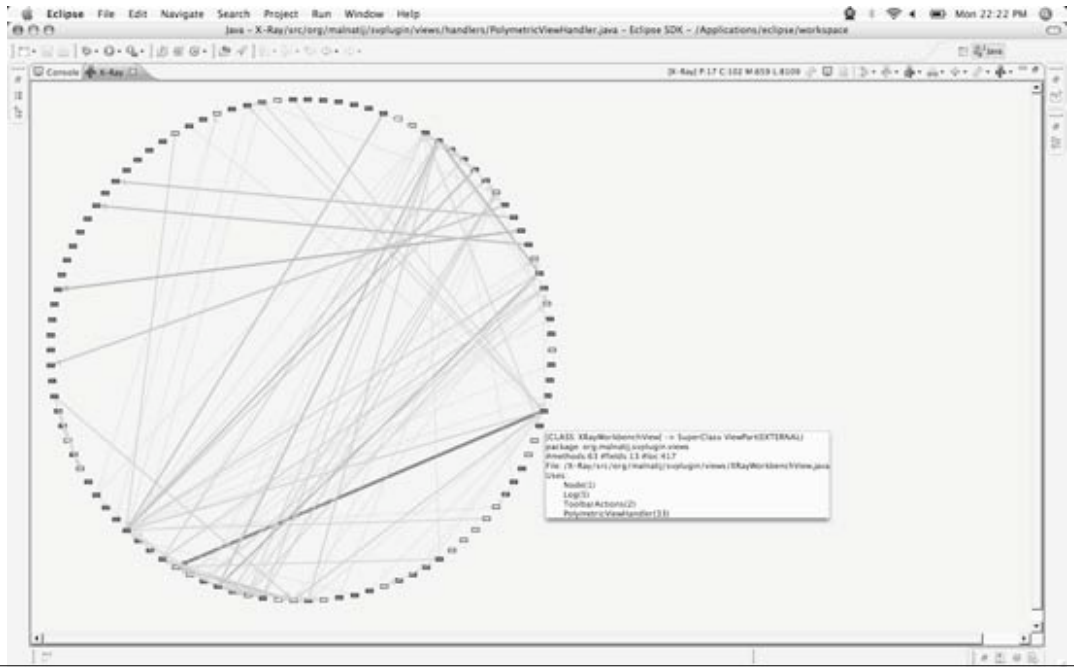
Azureus 3.0 (more than 500,000 lines of code)

x-ray itself

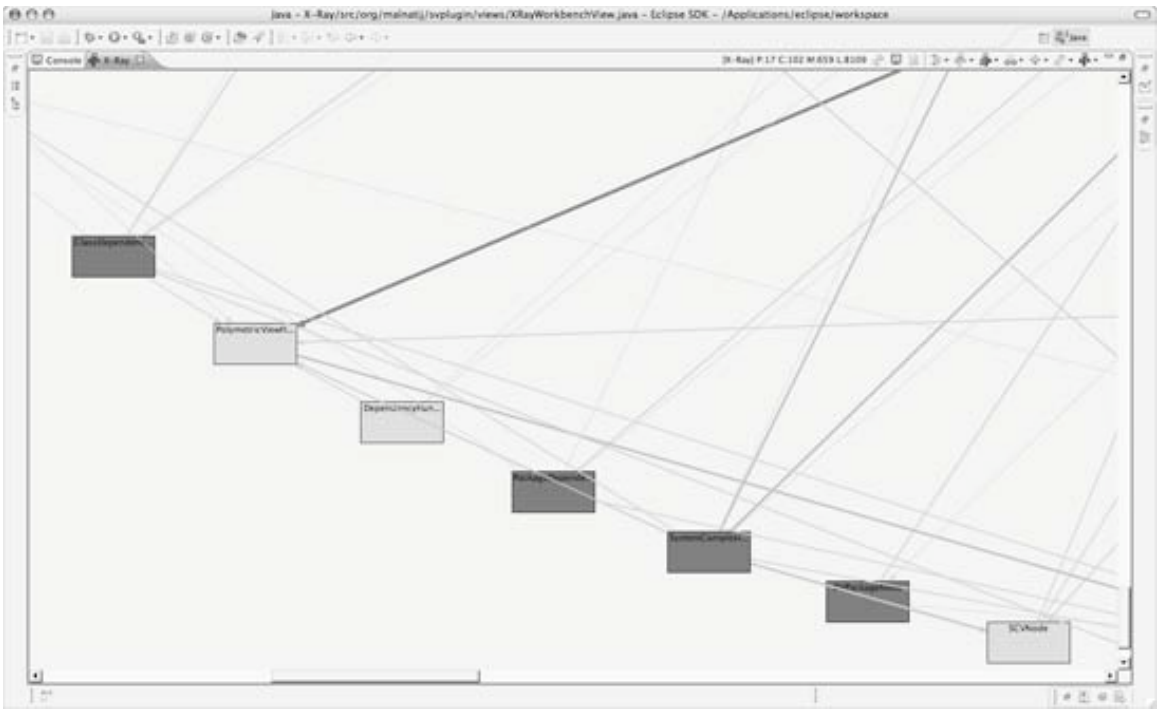
dependencies



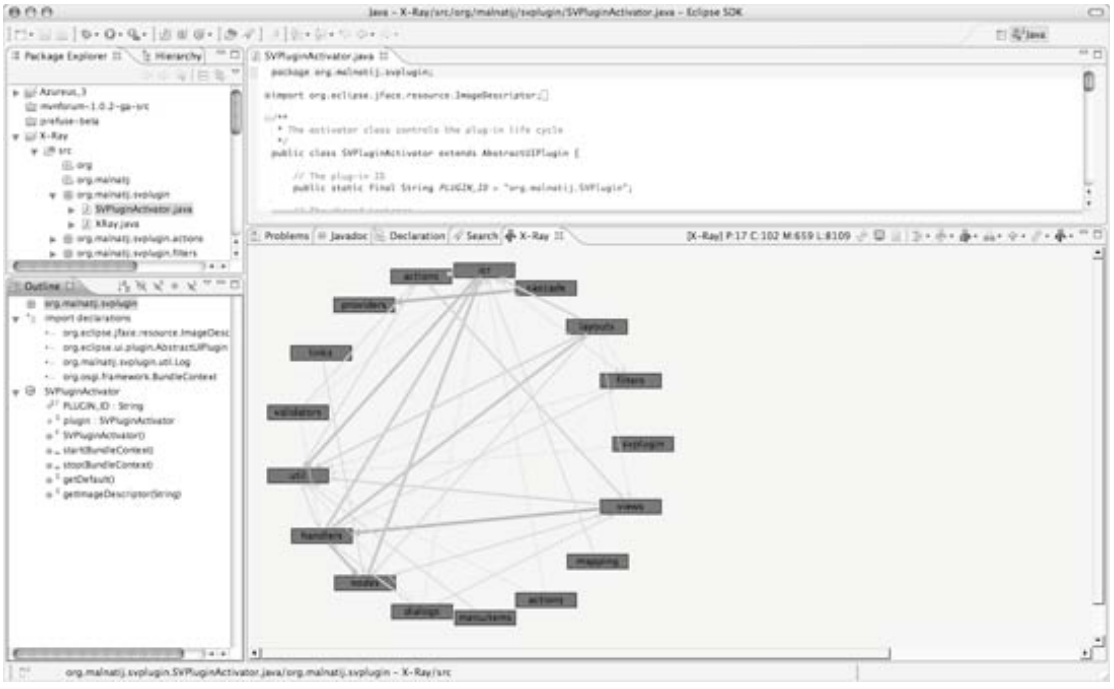
class & package dependency views



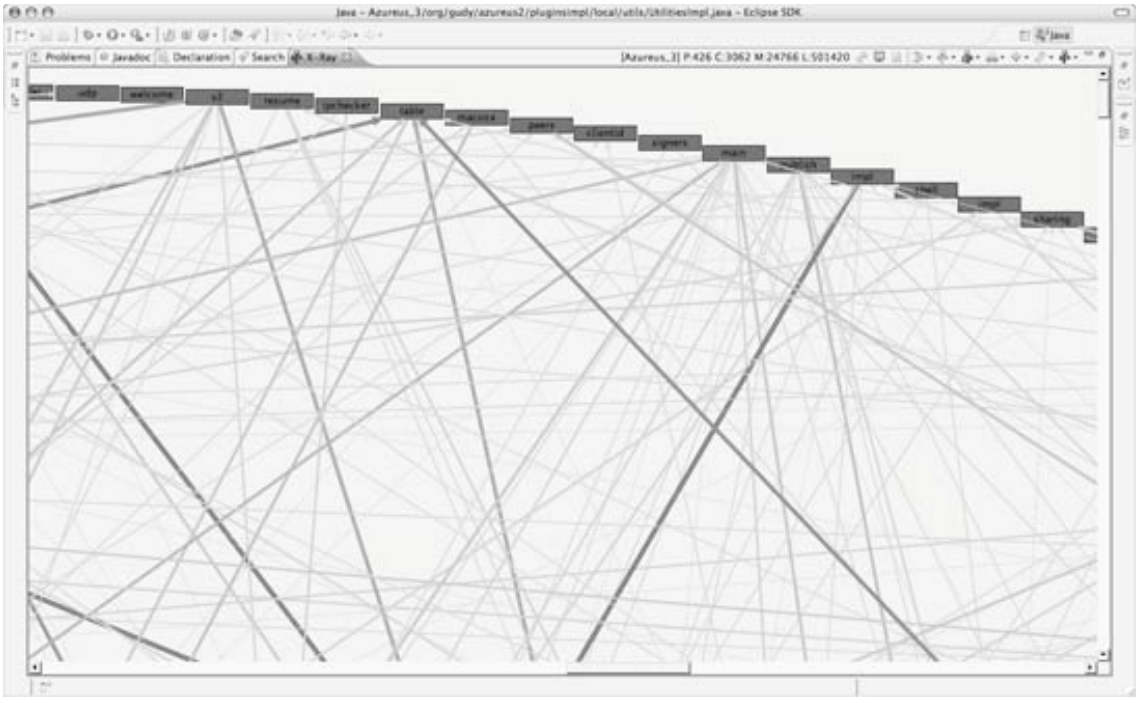
class dependency view



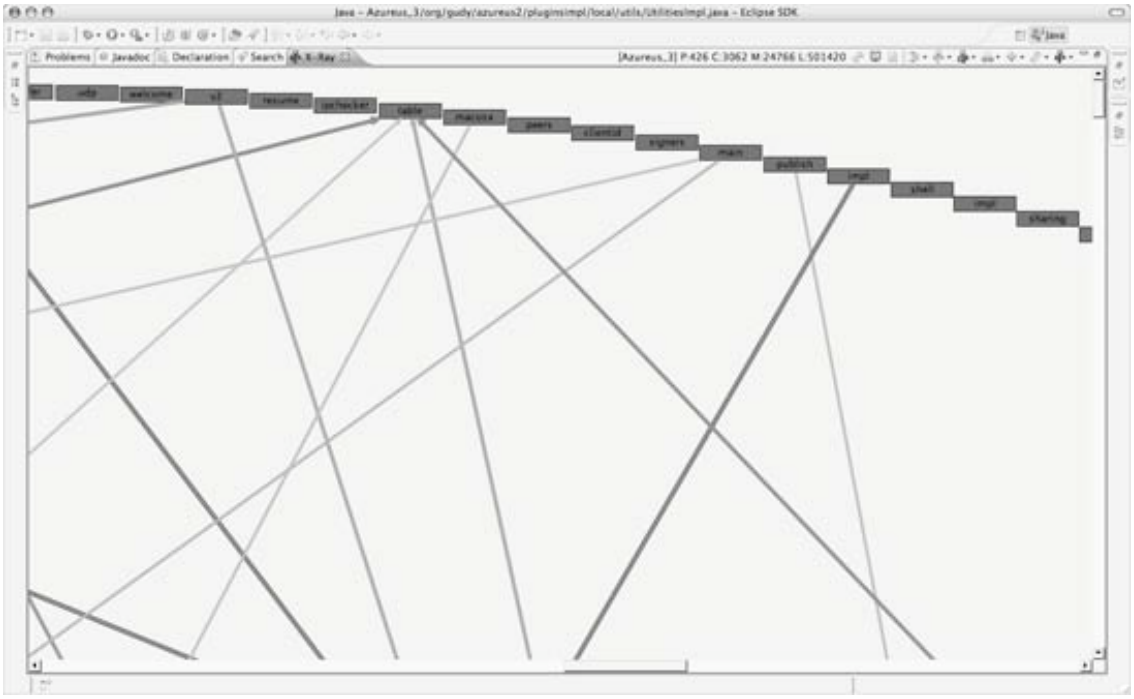
package dependency



Azureus packages



filtering (< 30 weight)



proximity alert

look for...

towers (=> lots of code, lots of methods)

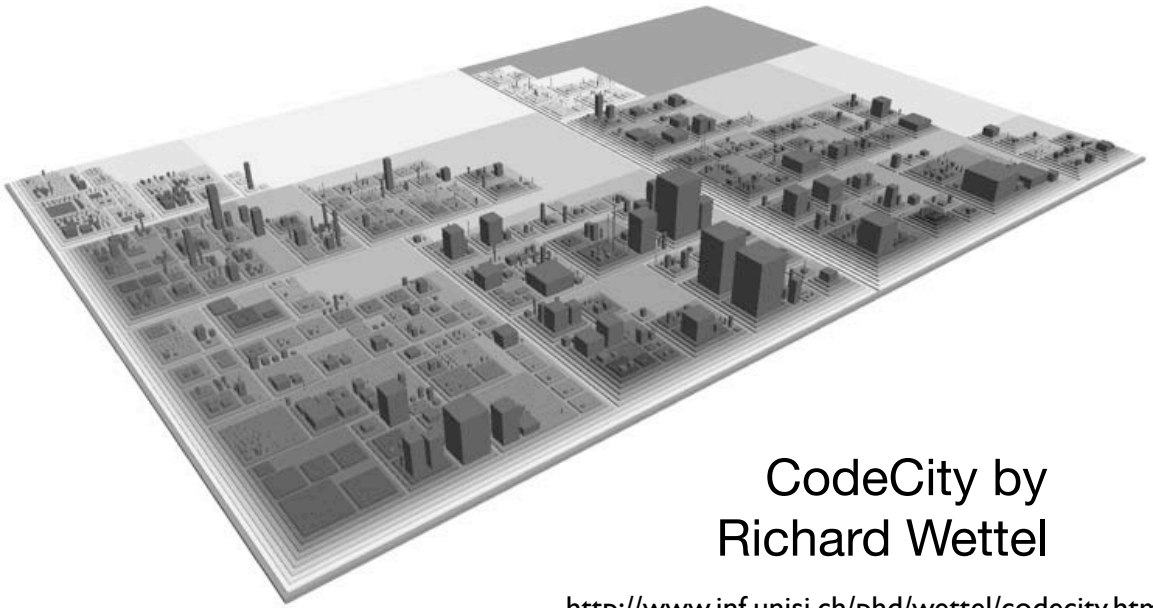
tangled dependencies

exuberant responsibility

natural partitions

balance

10,000 ft view (literally)



CodeCity by
Richard Wettel

http://www.inf.unisi.ch/phd/wettel/codecity.html

CodeCity

integrated environment for software analysis

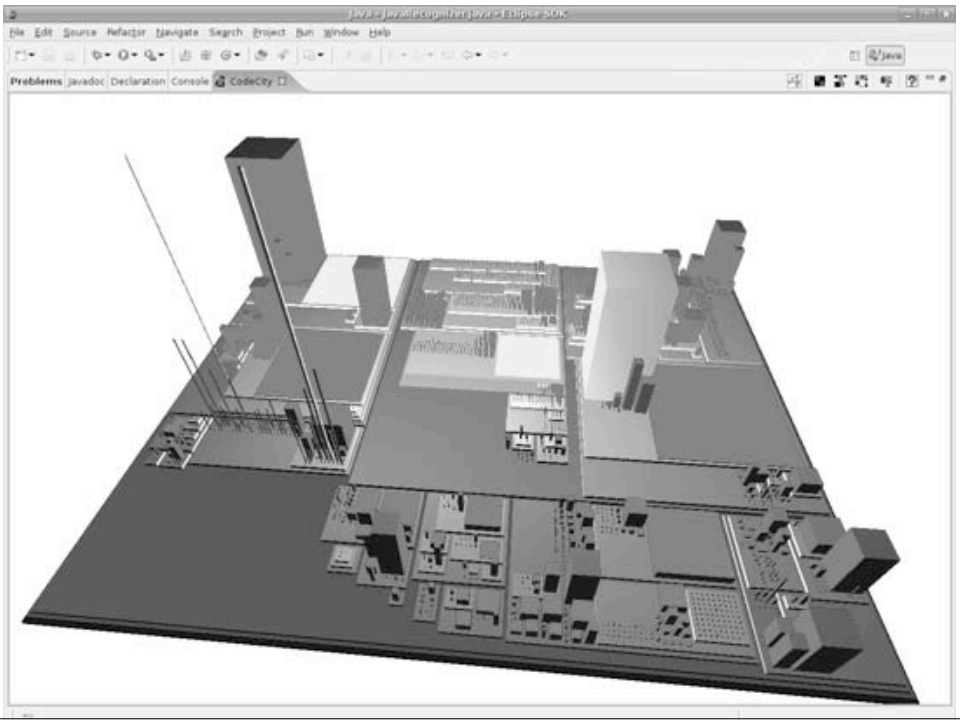
software systems are visualized as interactive, navigable 3D cities

written in VisualWorks Smalltalk, atop the Moose platform

classes => buildings

packages => districts

citylyzer



Citylyzer

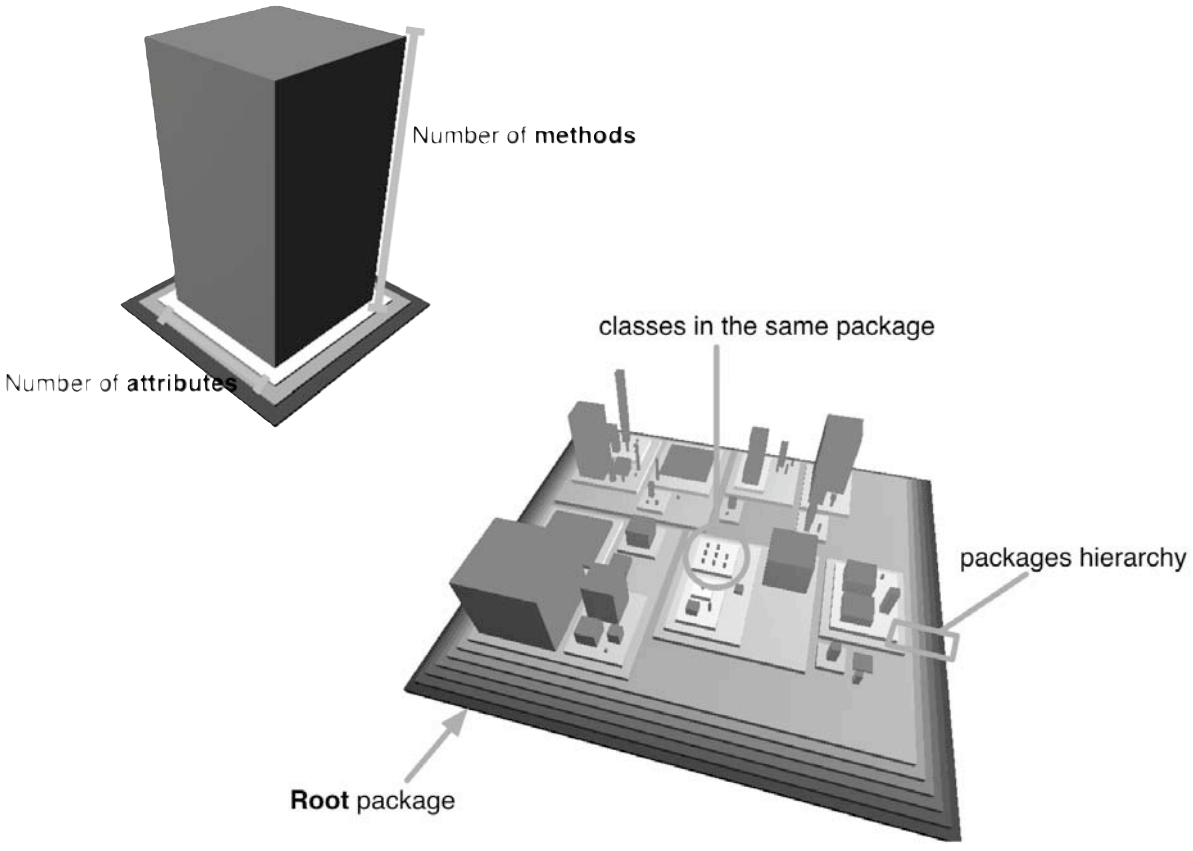
written atop x-ray

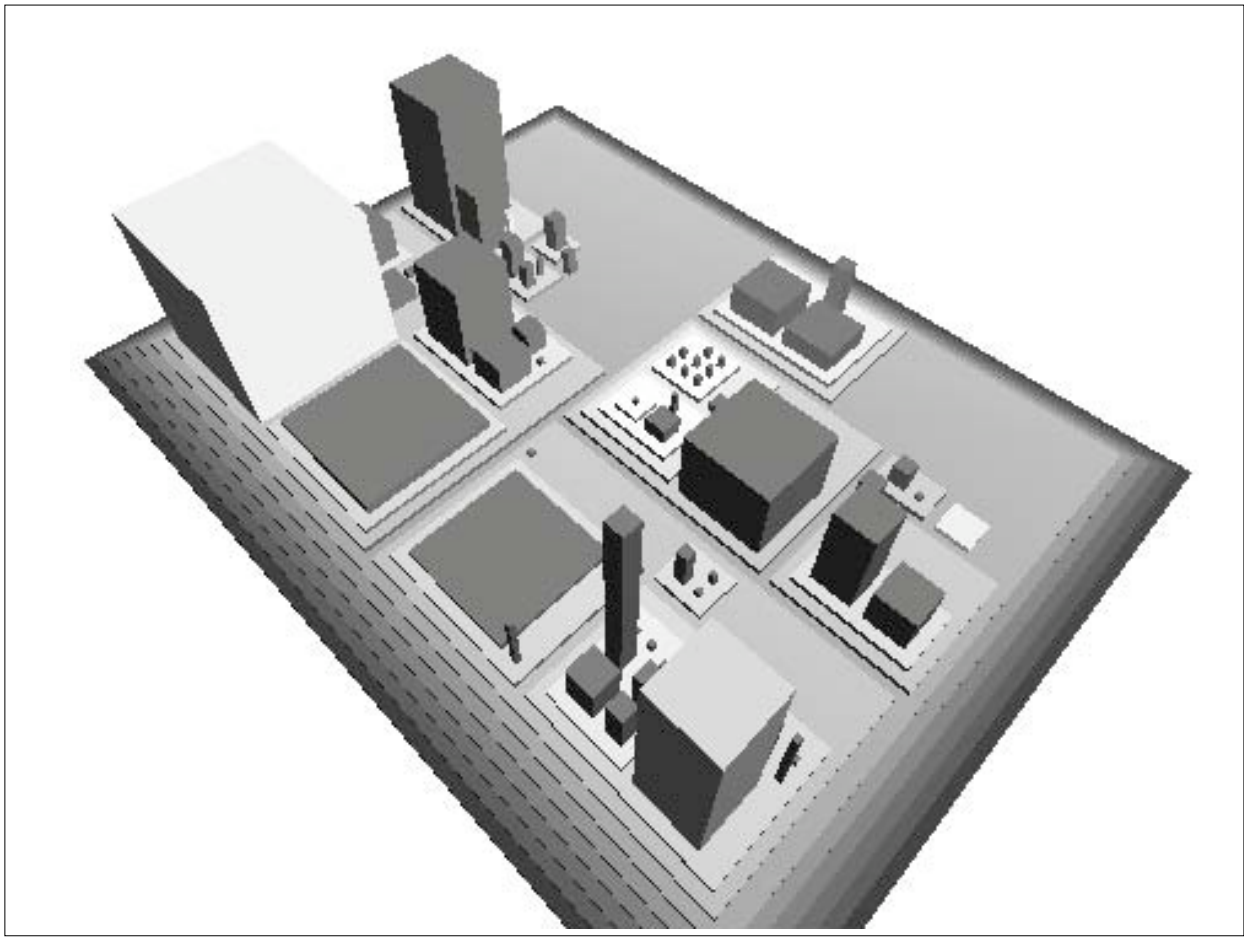
inspired by CodeCity

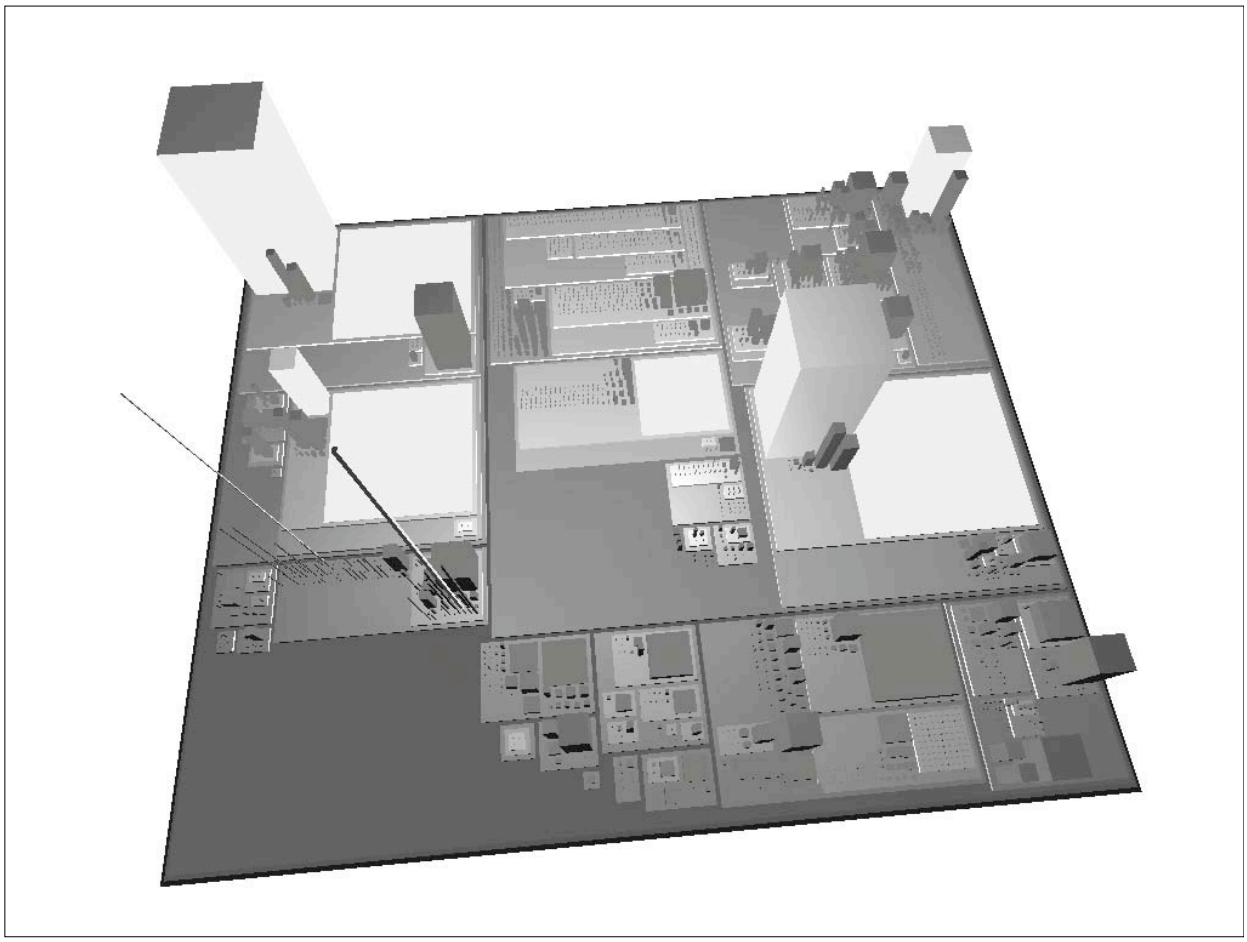
building height => number of methods

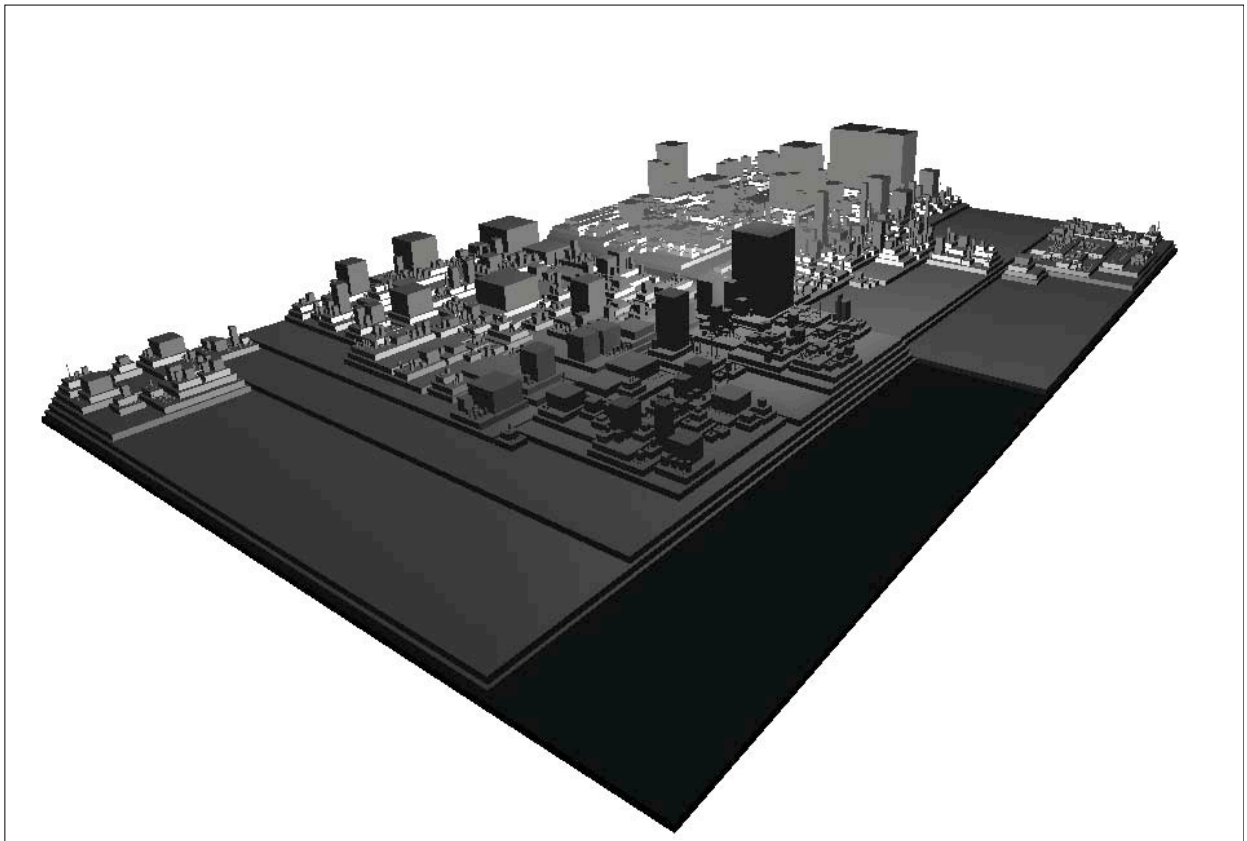
width/length => number of attributes

packages => districts









look for...

"real" cityscape

buildings that wouldn't exist in the real world

overly crowded neighborhoods

abandoned parts of town

would you live there?

? ' s

please fill out the session evaluations
samples at **`github.com/nealford`**

NEAL FORD software architect / meme wrangler

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