Design Quality Assessment in Practice

Radu Marinescu
radum@cs.upt.ro

my two hats...

Associate Professor

since 2006

Co-Founder and Head

since 2003

intooitus

http://www.intooitus.com/

Co-Founder (2008)

1

Assessment with metrics

2

Assessment with pictures

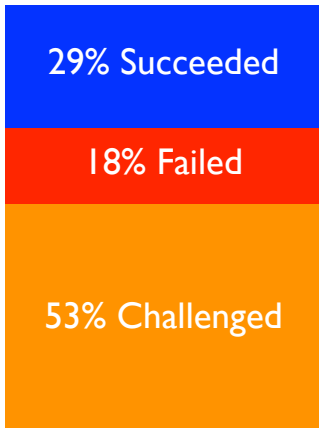
3

Assessment with tools

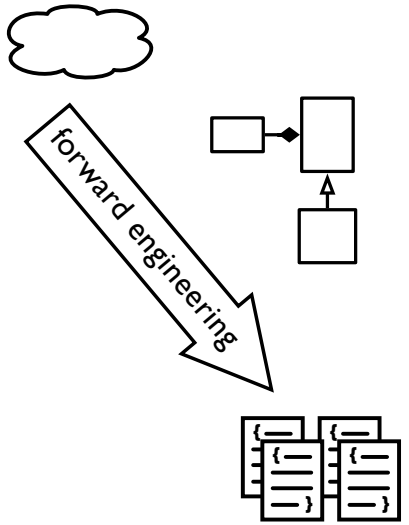
Assessment with metrics

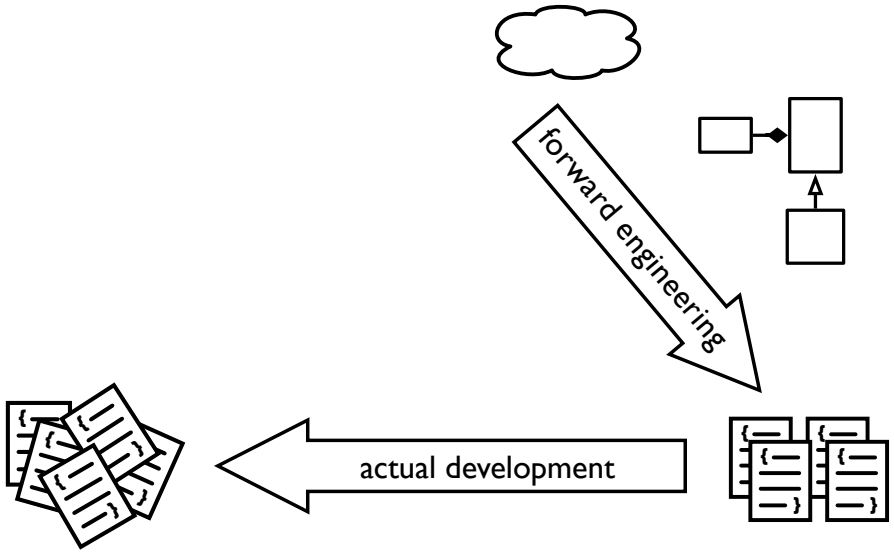
1

Software is complex.



The Standish Group, 2004





When, due to constraints,
I design *quickly and dirty*,
my project is loaded with

technical debt.

W.Cunningham, 1992

How can I **control** this...

You **cannot control**

what you **cannot measure**.

Tom de Marco

Metrics compress system traits into numbers.

Let's see some examples...

Examples of metrics

LOC - number of lines of code

CYCLO - cyclomatic complexity of a function

NOF - number of functions

FANOUT - outgoing coupling

NOA - number of attributes

DIT - depth of inheritance tree

TCC - tight class cohesion

Lorenz, Kidd, 1994
Chidamber, Kemerer, 1994

Trouble in paradise...

Trouble 1: Thresholds

Test		Results
ALB	=	2.9 g/dl
ALKP	=	136 U/L
ALT	=	48 U/L
AMYL	=	887 U/L
BUN	=	13 mg/dl
Ca	=	9.9 mg/dl
CREA	=	0.9 mg/dl
GLU	=	123 mg/dl
LIPA	=	613 U/L
PHOS	=	3.0 mg/dl
TBIL	=	0.3 mg/dl
TP	=	6.2 g/dl
GLOB	=	3.3 g/dl

Test		Results	Reference Range
ALB	=	2.9 g/dl	2.2 - 3.9
ALKP	=	136 U/L	23 - 212
ALT	=	48 U/L	10 - 100
AMYL	=	887 U/L	500 - 1500
BUN	=	13 mg/dl	7 - 27
Ca	=	9.9 mg/dl	7.9 - 12.0
CREA	=	0.9 mg/dl	0.5 - 1.8
GLU	=	123 mg/dl	74 - 149
LIPA	=	613 U/L	200 - 1800
PHOS	=	3.0 mg/dl	2.5 - 6.8
TBIL	=	0.3 mg/dl	0.0 - 0.9
TP	=	6.2 g/dl	5.2 - 8.2
GLOB	=	3.3 g/dl	2.5 - 4.5

Test		Results	Reference Range		Indicator LOW NORMAL HIGH
ALB	=	2.9 g/dl	2.2 -	3.9	
ALKP	=	136 U/L	23 -	212	
ALT	=	48 U/L	10 -	100	
AMYL	=	887 U/L	500 -	1500	
BUN	=	13 mg/dl	7 -	27	
Ca	=	9.9 mg/dl	7.9 -	12.0	
CREA	=	0.9 mg/dl	0.5 -	1.8	
GLU	=	123 mg/dl	74 -	149	
LIPA	=	613 U/L	200 -	1800	
PHOS	=	3.0 mg/dl	2.5 -	6.8	
TBIL	=	0.3 mg/dl	0.0 -	0.9	
TP	=	6.2 g/dl	5.2 -	8.2	
GLOB	=	3.3 g/dl	2.5 -	4.5	

Metric	Value
LOC	35175
NOM	3618
NOC	384
CYCLO	5579
NOP	
FANOUT	3590

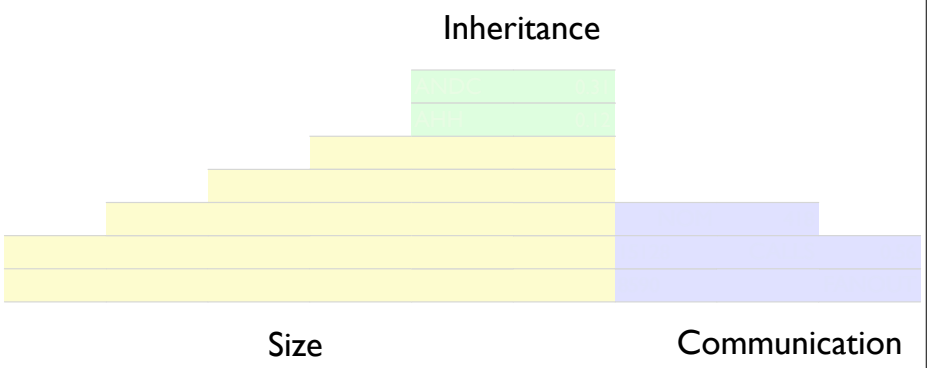
Are these numbers "**normal**" ?

We need means to compare.

We need comparable metrics.

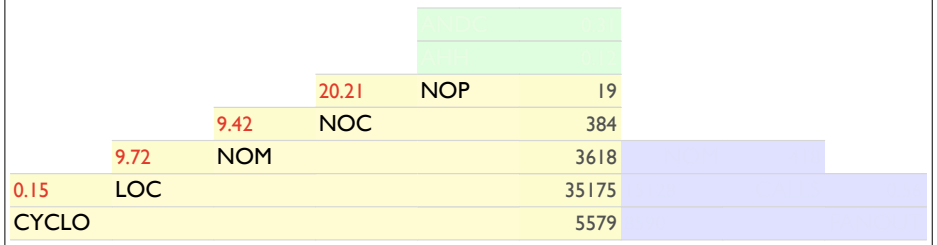
Overview Pyramid provides a metrics overview.

Marinescu, Lanza



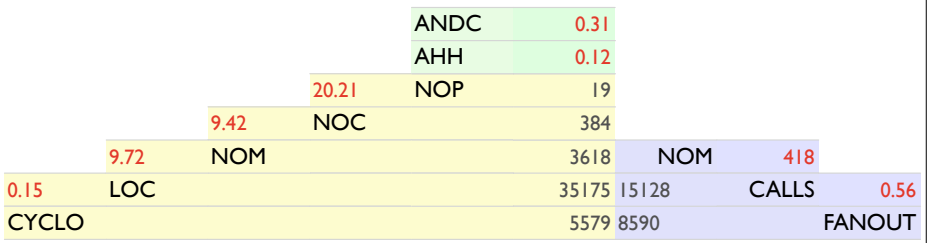
Overview Pyramid provides a metrics overview.

Marinescu, Lanza



Overview Pyramid provides a metrics overview.

Marinescu, Lanza



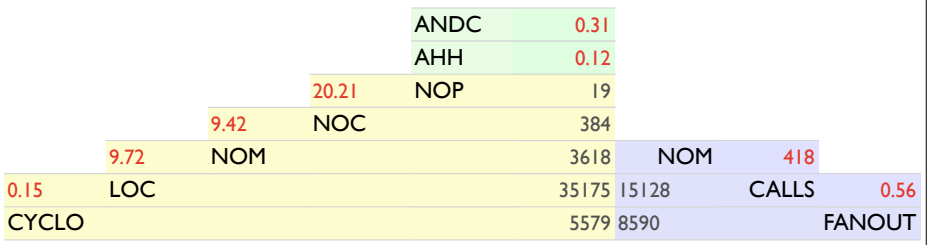
	Java			C++		
	LOW	AVG	HIGH	LOW	AVG	HIGH
CYCLO/LOC	0.16	0.20	0.24	0.20		0.30
LOC/NOM	7	10				16
NOM/NOC	4					15
...						

4.000+ OSS projects

500.000.000+ LOC

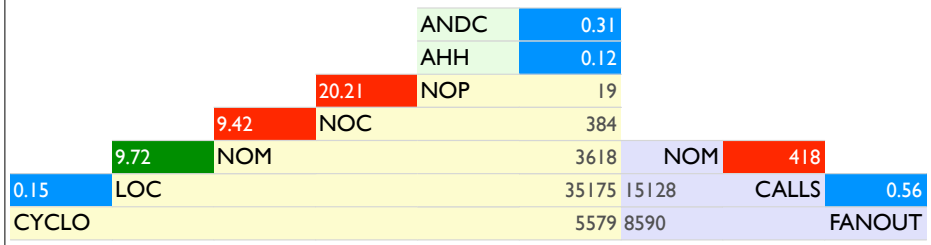
The Overview Pyramid provides a metrics overview.

Marinescu, Lanza



The Overview Pyramid provides a metrics overview.

Marinescu, Lanza



close to high close to average close to low

The Overview Pyramid provides a metrics overview.

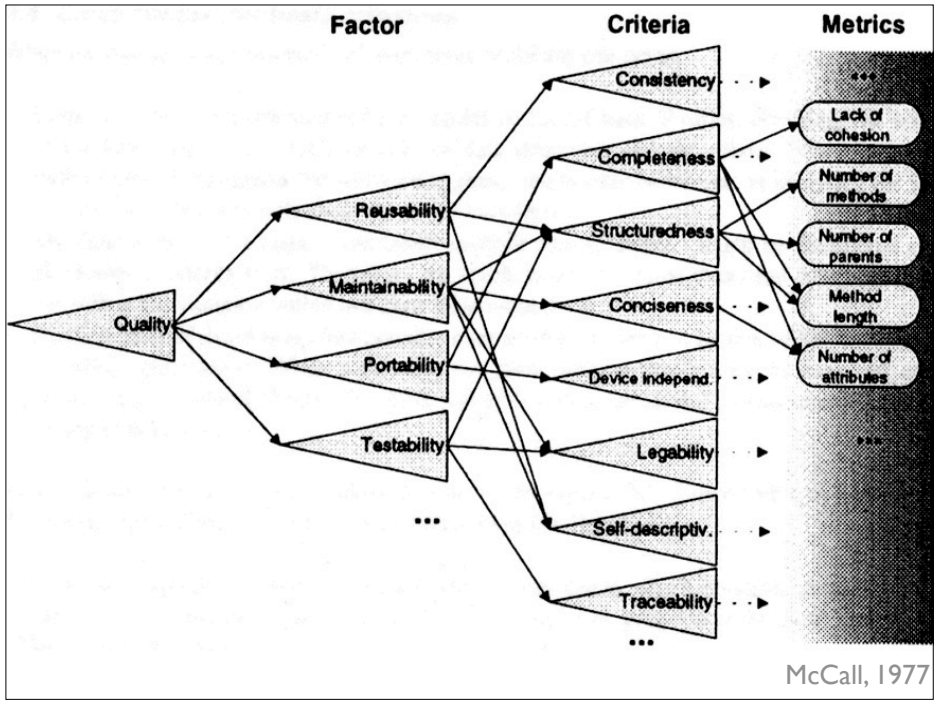
Marinescu, Lanza

close to high close to average close to low

Trouble 2: Granularity

Test	Results	Reference Range	Indicator
			LOW NORMAL HIGH
ALB	= 2.9 g/dl	2.2 - 3.9	
ALKP	= 136 U/L	23 - 212	
ALT	= 48 U/L	10 - 100	
AMYL	= 887 U/L	500 - 1500	
BUN	= 13 mg/dl	7 - 27	
Ca	= 9.9 mg/dl	7.9 - 12.0	
CREA	= 0.9 mg/dl	0.5 - 1.8	
GLU	= 123 mg/dl	74 - 149	
LIPA	= 613 U/L	200 - 1800	
PHOS	= 3.0 mg/dl	2.5 - 6.8	
TBIL	= 0.3 mg/dl	0.0 - 0.9	
TP	= 6.2 g/dl	5.2 - 8.2	
GLOB	= 3.3 g/dl	2.5 - 4.5	

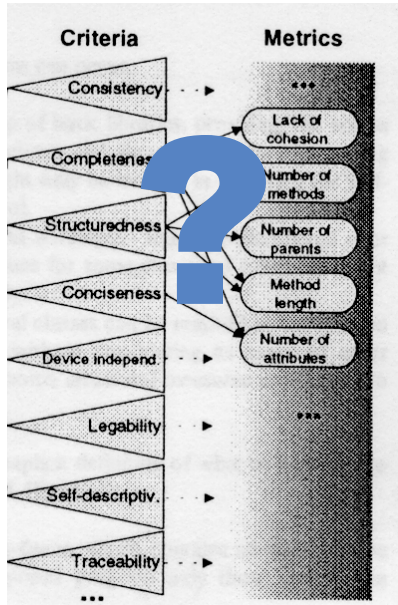
Metrics are aggregated in quality models...



McCall, 1977

Problem:

we don't reason in terms of metrics, but in terms of design principles

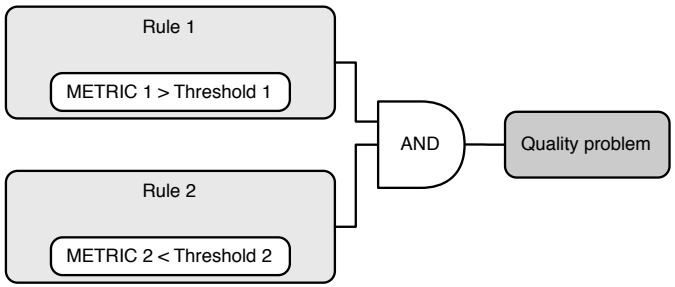


Capture violations of design principles & best practices in an automatic manner...

An example...

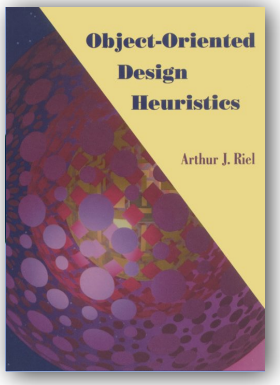
Detection Strategies are metric-based queries to detect design flaws.

Marinescu



God Classes tend to centralize the intelligence of the system, to do everything and to use data from small data-classes.

A.Riel, 1996



God Classes tend
to centralize the intelligence of the system,
to do everything and
to use data from small data-classes.

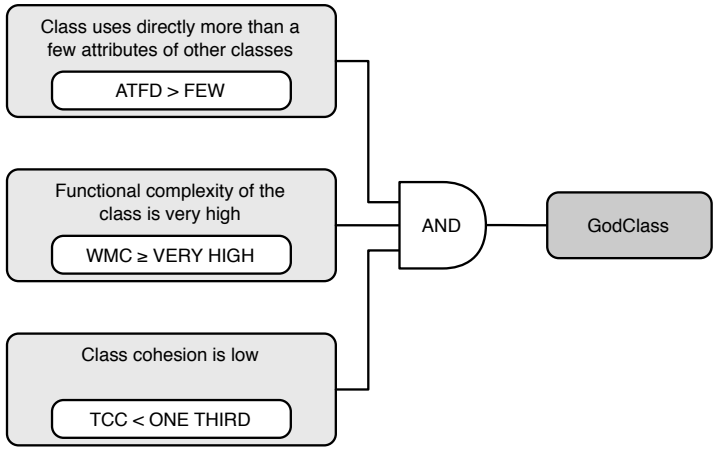
God Classes
centralize the intelligence of the system,
do everything and
use data from small data-classes.

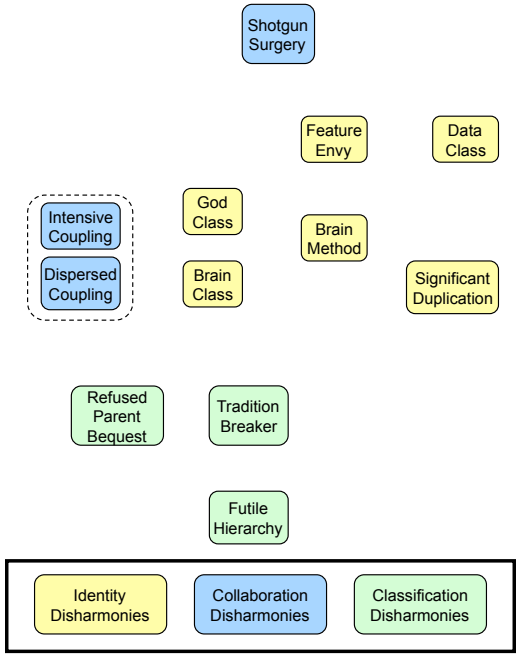
God Classes
are complex,
are not cohesive,
access external data.

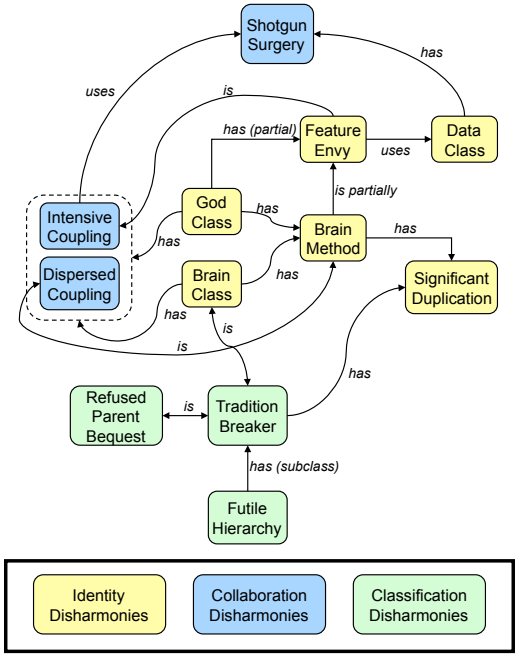
Compose metrics into queries using logical operators

A God Class centralizes too much intelligence in the system.

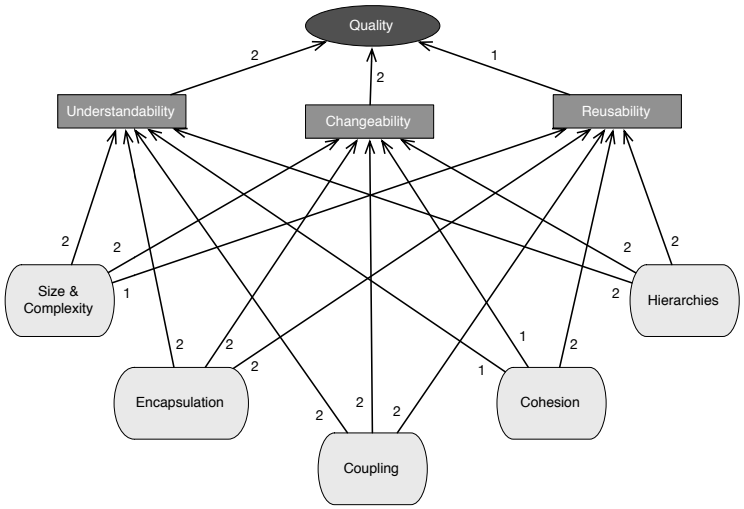
Marinescu, Lanza



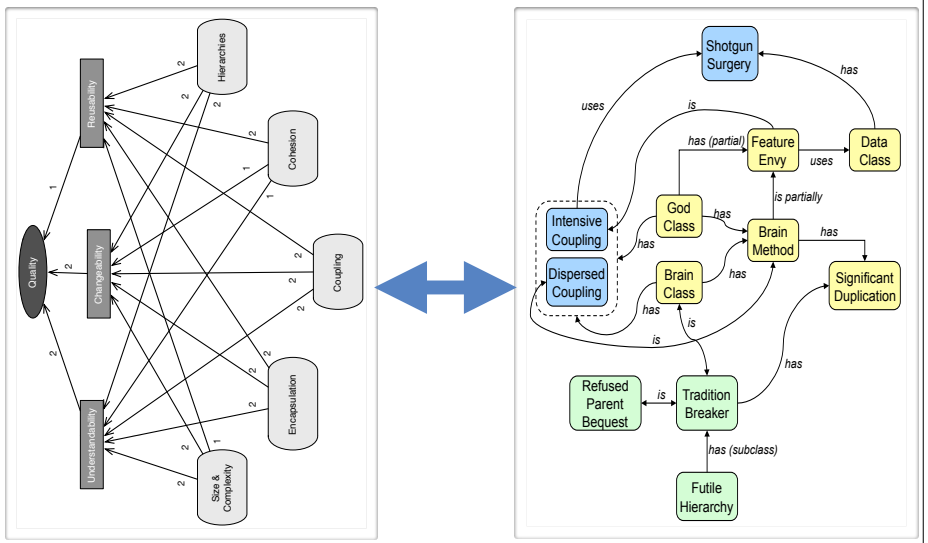




Measure quality deficit based on design problems



Measure quality deficit based on design problems



Analysis name	Impact class
Blob Class	class
Significant External Duplication	system
Significant Hierarchy Duplication	hierarchy
Significant Internal Duplication	class
God Class	system
Data Class	system
Data Clumps	system
Intensive Coupling	class
Dispersed Coupling	system
Shotgun Surgery	system
Cyclic Dependencies (ADP Breakers)	system
Unnecessary Coupling	system
Unstable Dependencies (SDP Breakers)	system
Schizophrenic Class (SRP, ISP)	class
Feature Envy	class
Refused Parent Bequest (LSP)	hierarchy
Tradition Breaker (SRP)	hierarchy
SAP Breakers (DIP)	system
Distorted Hierarchy (deep and narrow)	hierarchy

Impact class	Weight
class	1
hierarchy	3
system	5

Analysis name	Impact class	Relative Impact level (L/H)				
		SCOMP	ENC	CPL	COH	HIE
Blob Class	class	H		L	L	
Significant External Duplication	system	H	L	L		
Significant Hierarchy Duplication	hierarchy	H	L	L		H
Significant Internal Duplication	class	H	L			
God Class	system	H	H	H	L	L
Data Class	system	L	H	L	L	
Data Clumps	system	L	H			
Intensive Coupling	class	H		L		H
Dispersed Coupling	system	H		H		
Shotgun Surgery	system			H		
Cyclic Dependencies (ADP Breakers)	system	H		H		
Unnecessary Coupling	system	L		H		
Unstable Dependencies (SDP Breakers)	system	L		H		
Schizophrenic Class (SRP, ISP)	class	H		L	H	H
Feature Envy	class	L	H	H	L	L
Refused Parent Bequest (LSP)	hierarchy	H			H	H
Tradition Breaker (SRP)	hierarchy	H		L	L	H
SAP Breakers (DIP)	system	L		L		H
Distorted Hierarchy (deep and narrow)	hierarchy	H	L			H

Impact class	Weight
class	1
hierarchy	3
system	5

Impact level	Weight
L	1
H	2

Stay tuned for the inFusion demo

1

Assessment with metrics

2

Assessment with pictures

3

Assessment with tools

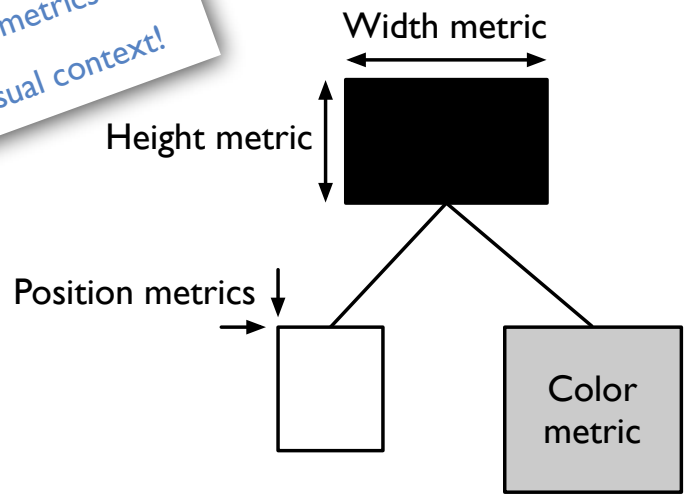
2

Assessment with pictures

Polymetric views show up to 5 metrics

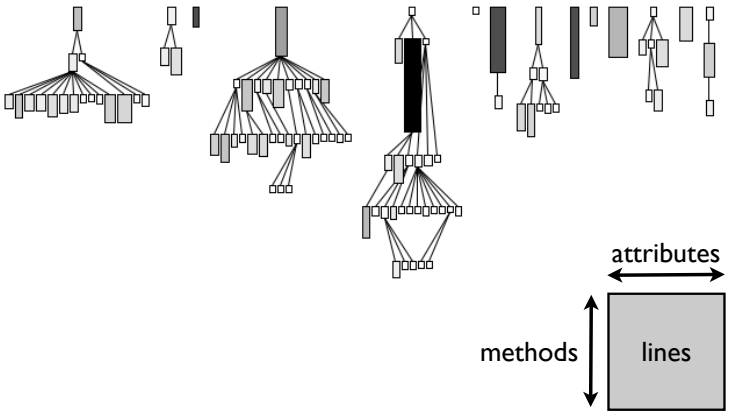
Lanza, Ducasse, 2003

Use metrics in a visual context!

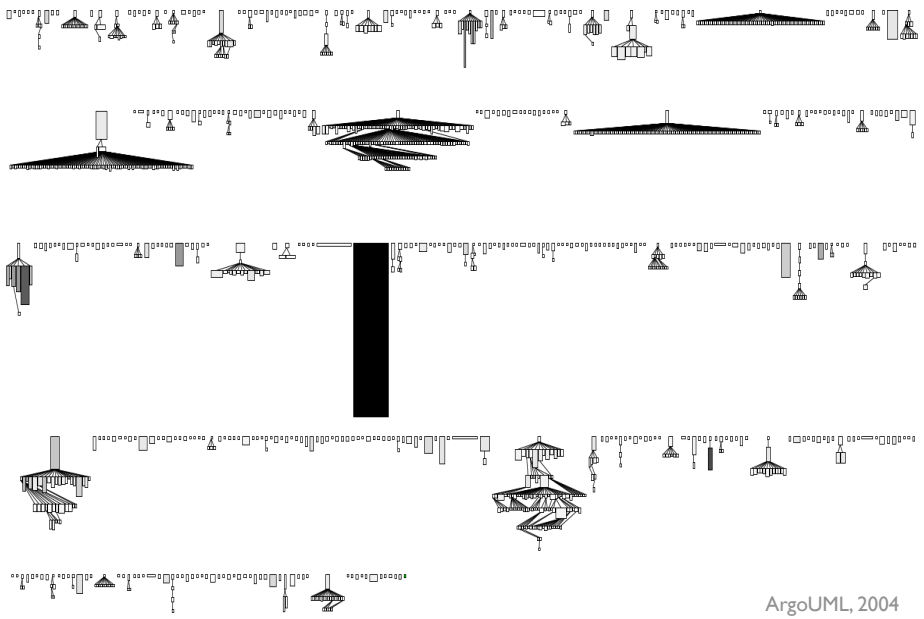


Example

System Complexity shows class hierarchies

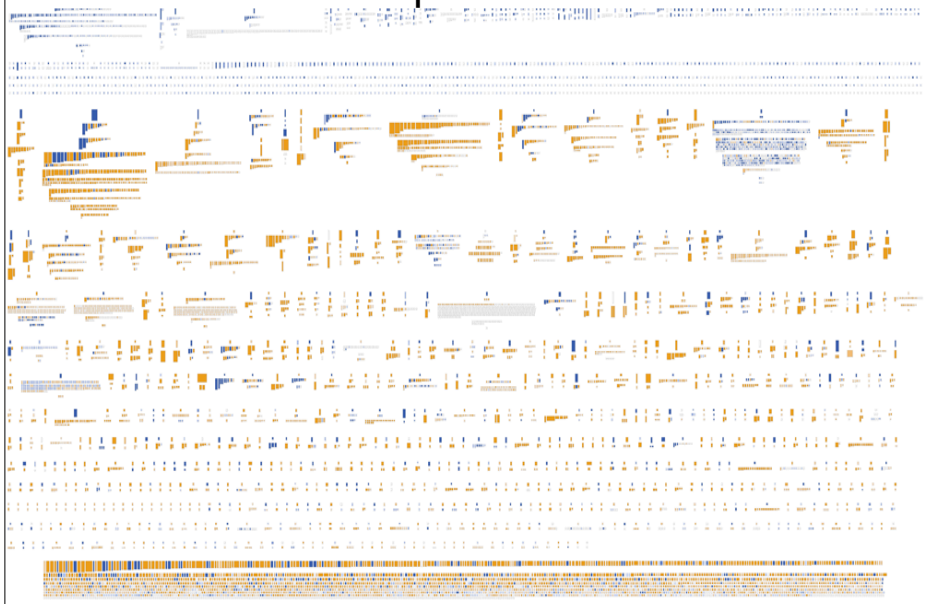


1000+ classes in one picture...



ArgoUML, 2004

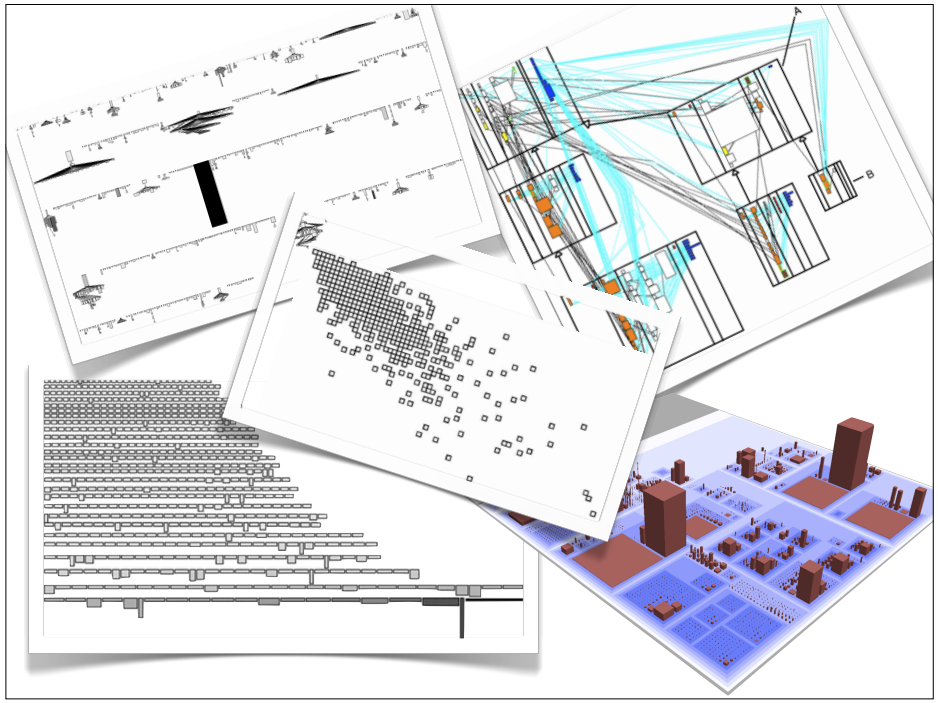
11.000+ classes in one picture...



Java JDK 1.5, 2011

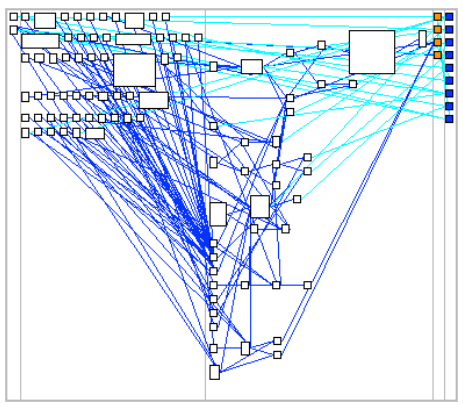
Trouble in paradise...

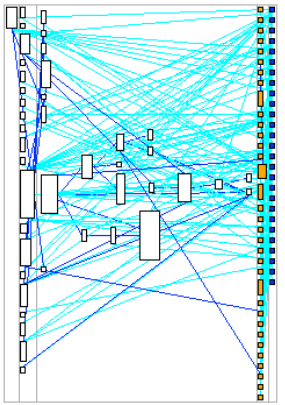
Trouble 1: Heterogeneity

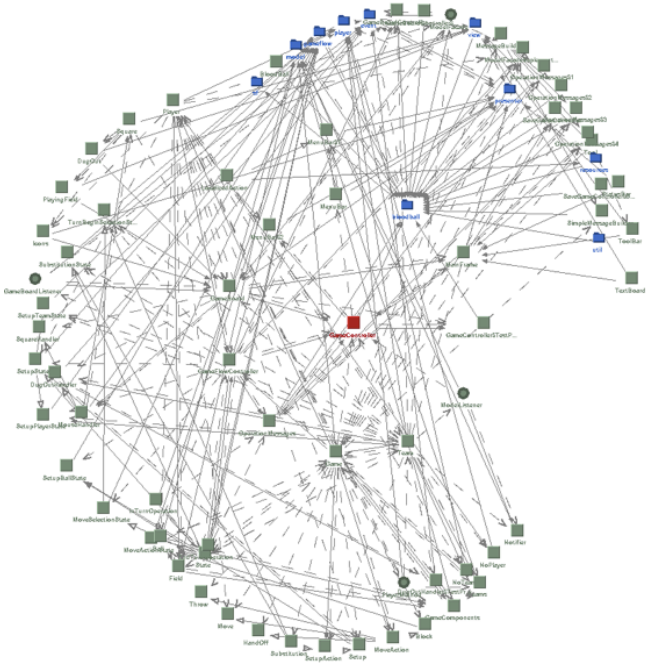


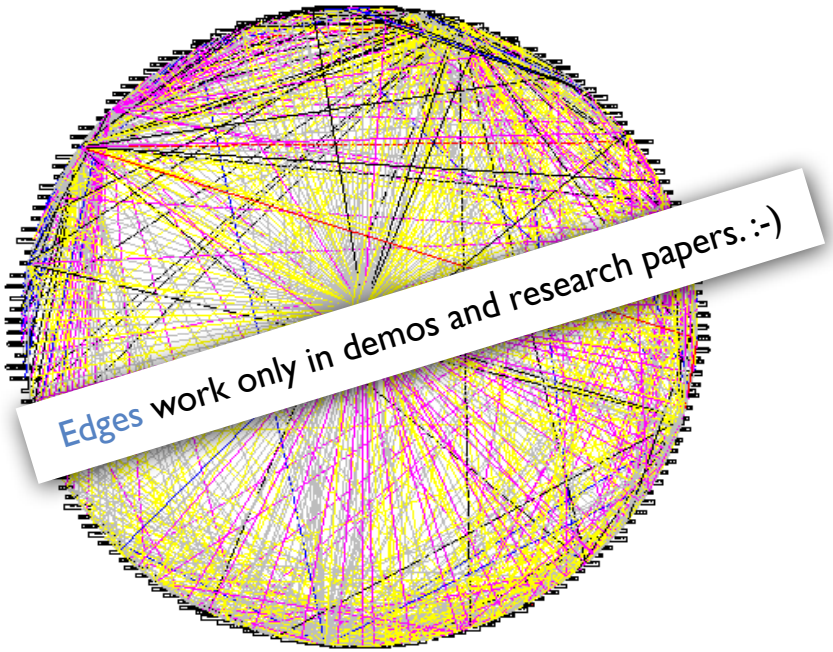
They are simply too many...

Trouble 2: Edges are a pain...









Beyond polymetric views...

Polymetric Maps

Visualize various design concerns.

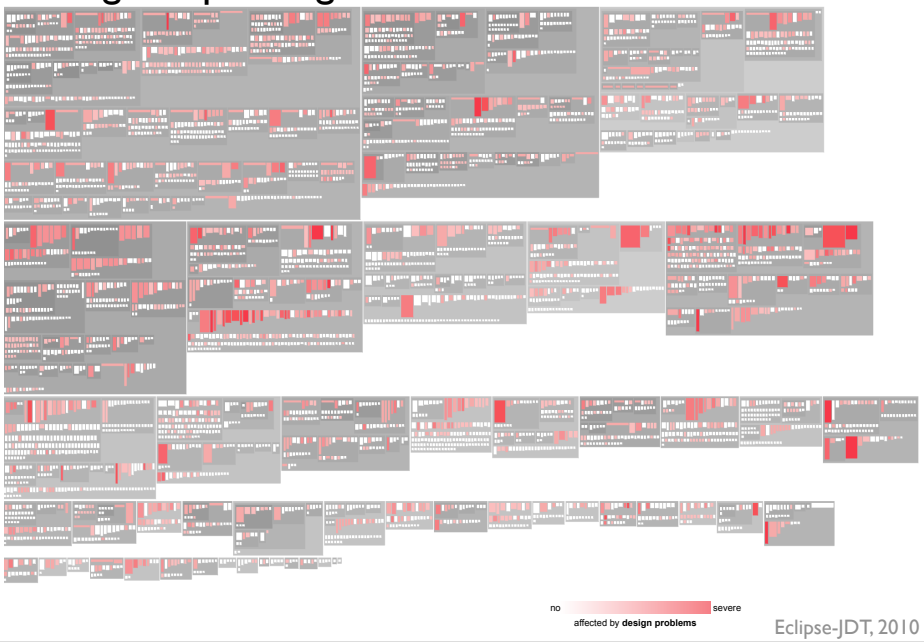
Reuse the layout!

Example: Package Maps

Package Map: Layout

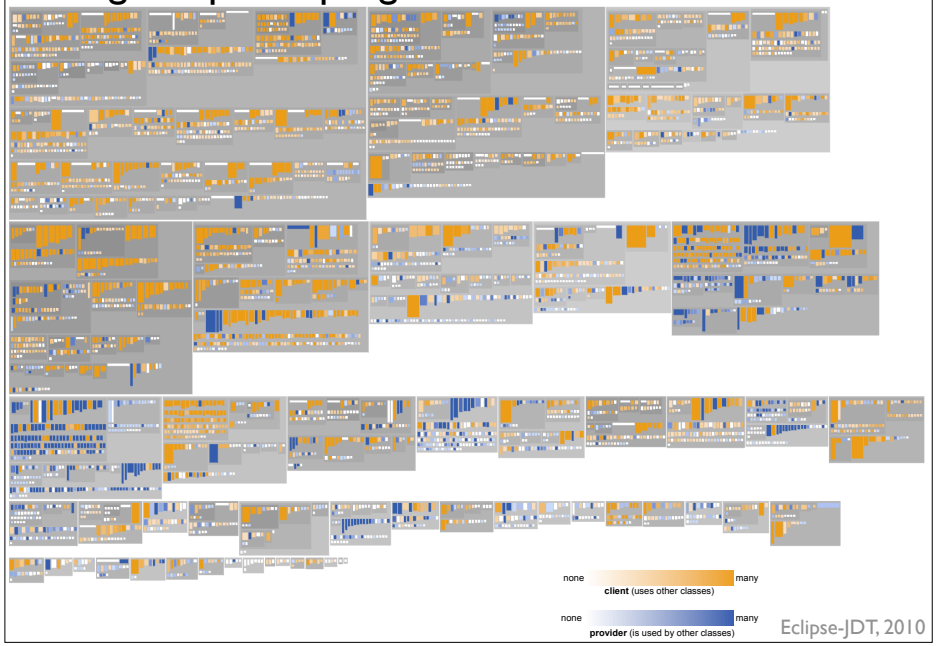
Eclipse-JDT, 2010

Package Map: Design Problems



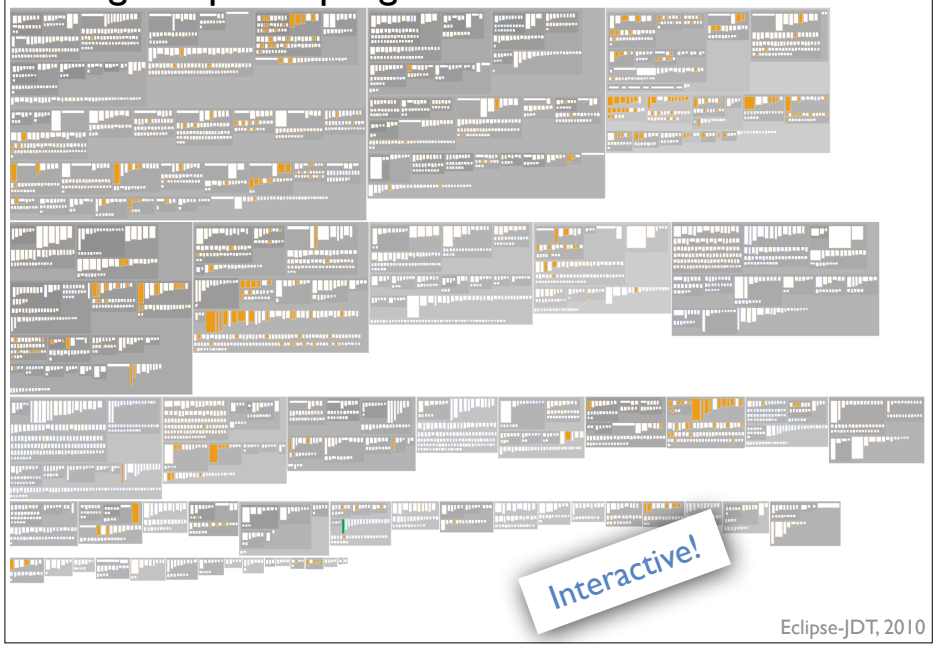
Eclipse-JDT, 2010

Package Map: Coupling



Eclipse-JDT, 2010

Package Map: Coupling



Eclipse-JDT, 2010

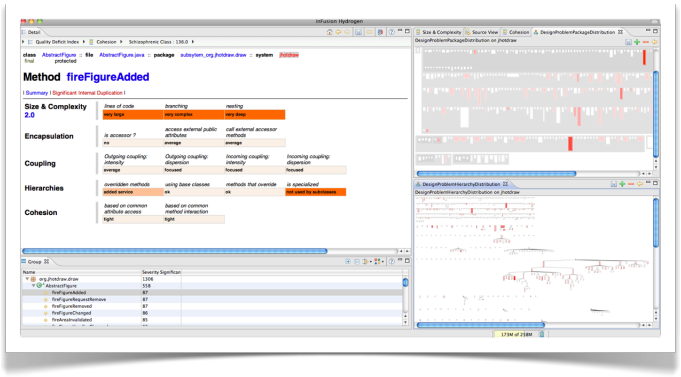
A picture is worth a thousand words

Proverb

A demo is worth a thousand pictures

Assessment with tools

inFusion



inFusion

1. **Quality Deficit** becomes quantifiable
2. Detection of well-know **design problems**
3. Meaningful **contextual advices**
4. Interactive **visualizations**

13.5 MLOC

A demo is worth a thousand pictures

It's **demo** time!

Try out inFusion yourself!

http://www.intooitus.com/products/infusion

Design Quality Assessment in Practice

Radu Marinescu
radum@cs.upt.ro