Pragmatic Design Quality Assessment

Extracted Slides

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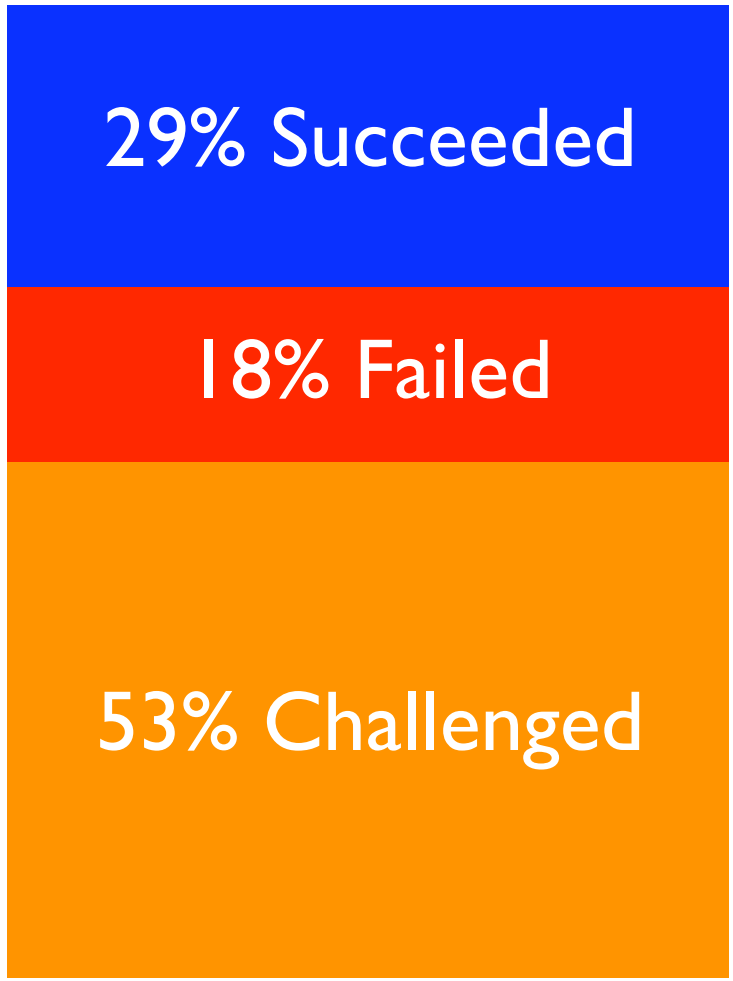
Software is complex.



The Standish Group, 2004

How large is your project?

1’000’000 lines of code

How large is your project?

1’000’000 lines of code

* 2 = 2’000’000 seconds

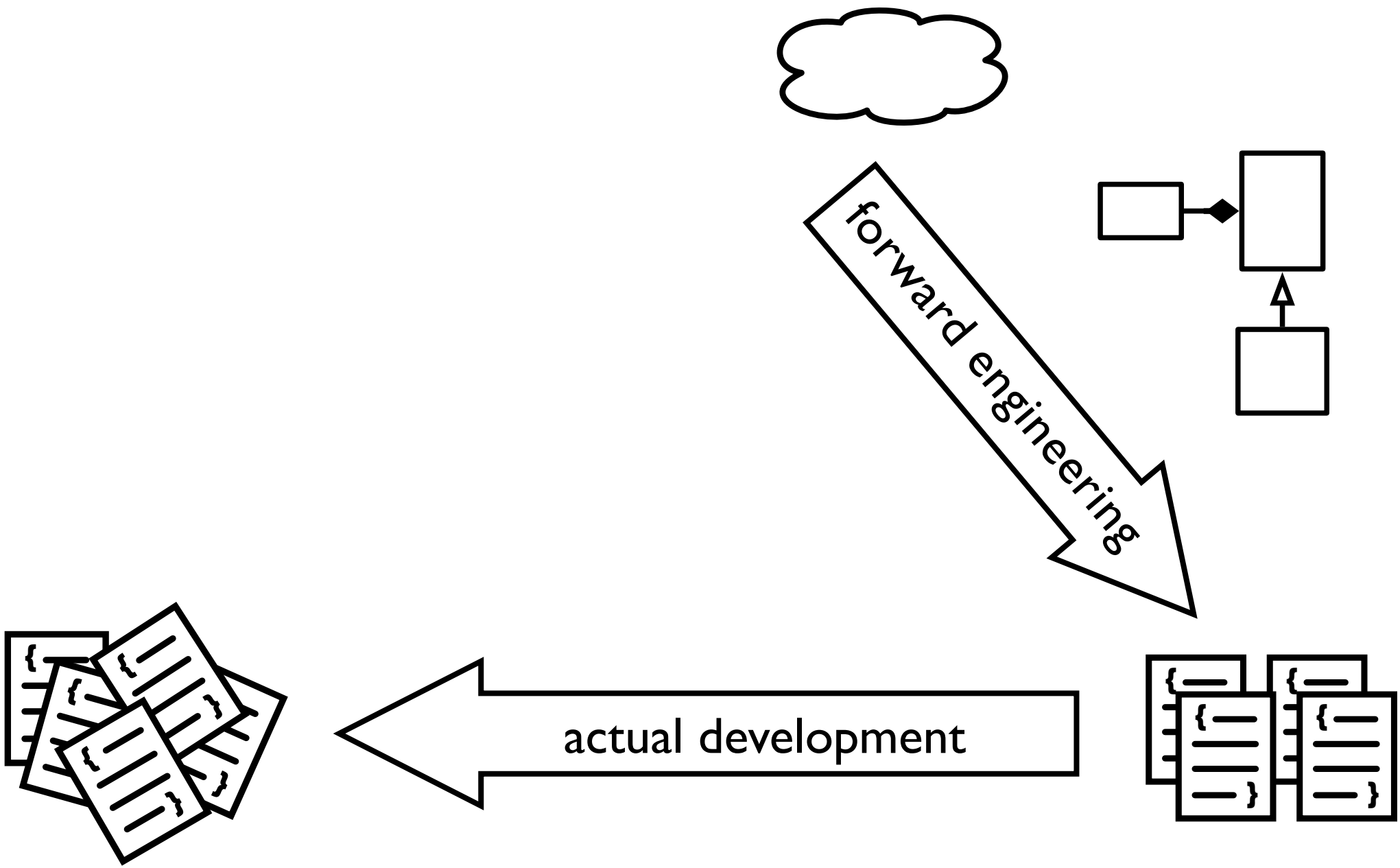
/ 3600 = 560 hours

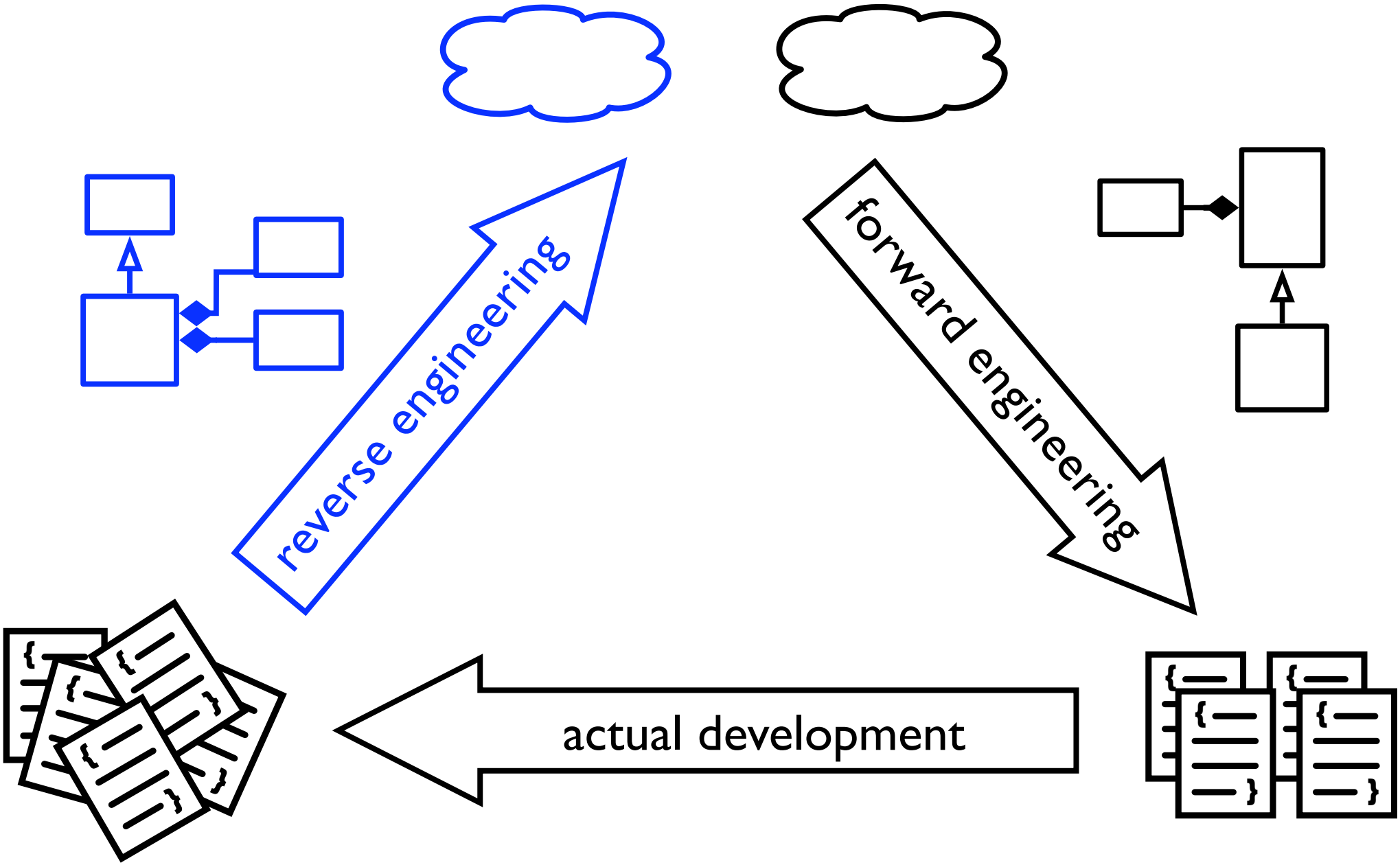
/ 8 = 70 days

/ 20 = 3 months

But, code is for the computer.

Why would we ever read it?


forward engineering
actual development

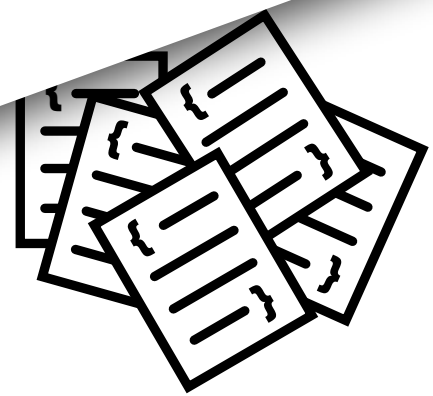

reverse engineering
forward engineering
actual development

Reverse engineering is analyzing a subject system to:

identify components and their relationships, and create more abstract representations.

Chikofky & Cross, 90

How to judge its quality?



A large system contains lots of details.

Software in numbers

You cannot control

what you cannot measure.

Tom de Marco

Metrics are functions that assign numbers to products, processes and resources.

Software metrics are measurements which relate to software systems, processes or related documents.

Metrics compress system traits into numbers.

Let's see some examples...

Examples of size metrics

NOM - number of methods

NOA - number of attributes

LOC - number of lines of code

NOS - number of statements

NOC - number of children

Lorenz, Kidd, 1994

Chidamber, Kemerer, 1994

McCabe cyclomatic complexity (CYCLO) counts the number of independent paths through the code of a function.

McCabe, 1977

✓ it reveals the minimum number of tests to write

✗ interpretation can't directly lead to improvement action

Weighted Method Count (WMC) sums up the complexity of class' methods (measured by the metric of your choice; usually CYCLO).

Chidamber, Kemerer, 1994

✓ it is configurable, thus adaptable to our precise needs

✗ interpretation can't directly lead to improvement action

Depth of Inheritance Tree (DIT) is the (maximum) depth level of a class in a class hierarchy.

Chidamber, Kemerer, 1994

✓ inheritance is measured

✗ only the potential and not the real impact is quantified

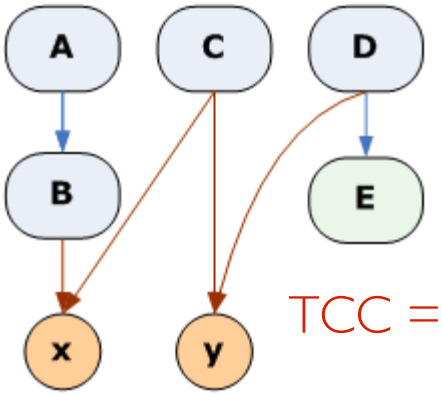
Coupling between objects (CBO) shows the number of classes from which methods or attributes are used.

Chidamber, Kemerer, 1994

✓ it takes into account real dependencies not just declared ones

✗ no differentiation of types and/or intensity of coupling

Tight Class Cohesion (TCC) counts the relative number of method-pairs that access attributes of the class in common.



TCC = 2 / 10 = 0.2

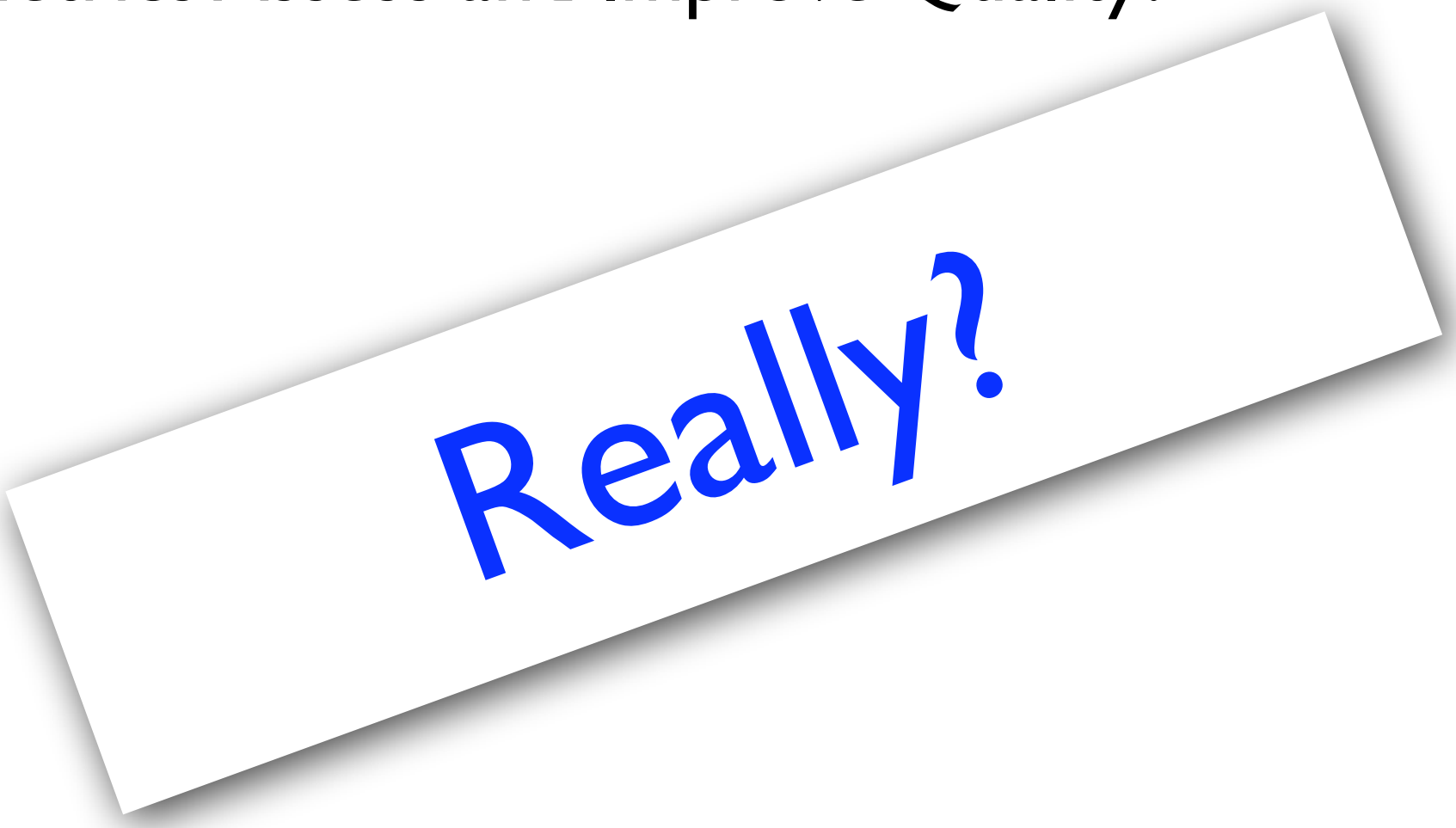
Bieman, Kang, 1995

✓ interpretation can lead to improvement action

✓ ratio values allow comparison between systems

Metrics Assess and Improve Quality!

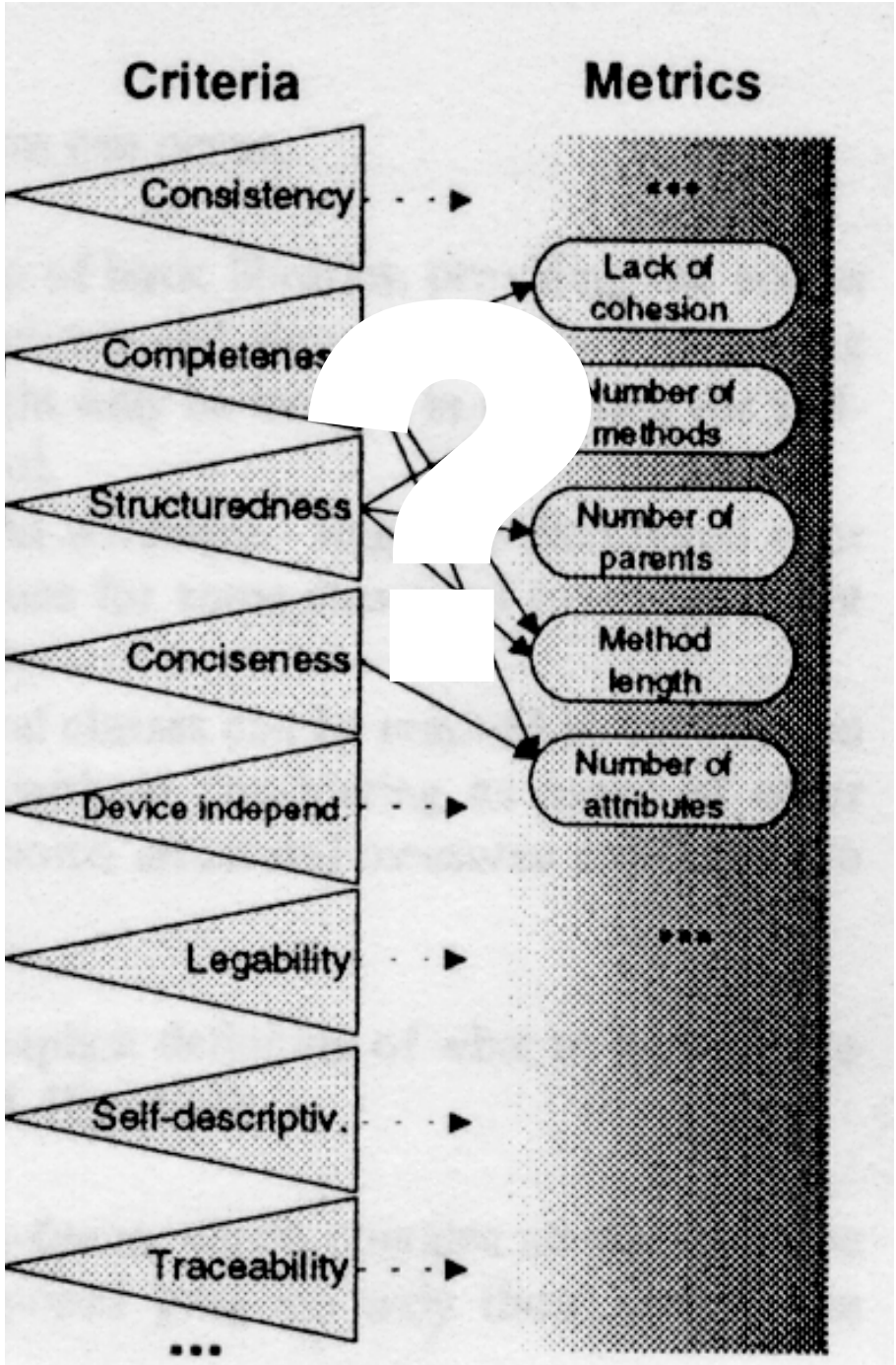
Metrics Assess and Improve Quality!



Problem 1: metrics granularity

capture symptoms, not causes of problems

in isolation,
they don't lead to improvement solutions



Problem 2: implicit mapping

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

2 big obstacles in using metrics:

Thresholds make metrics hard to interpret

Granularity make metrics hard to use in isolation

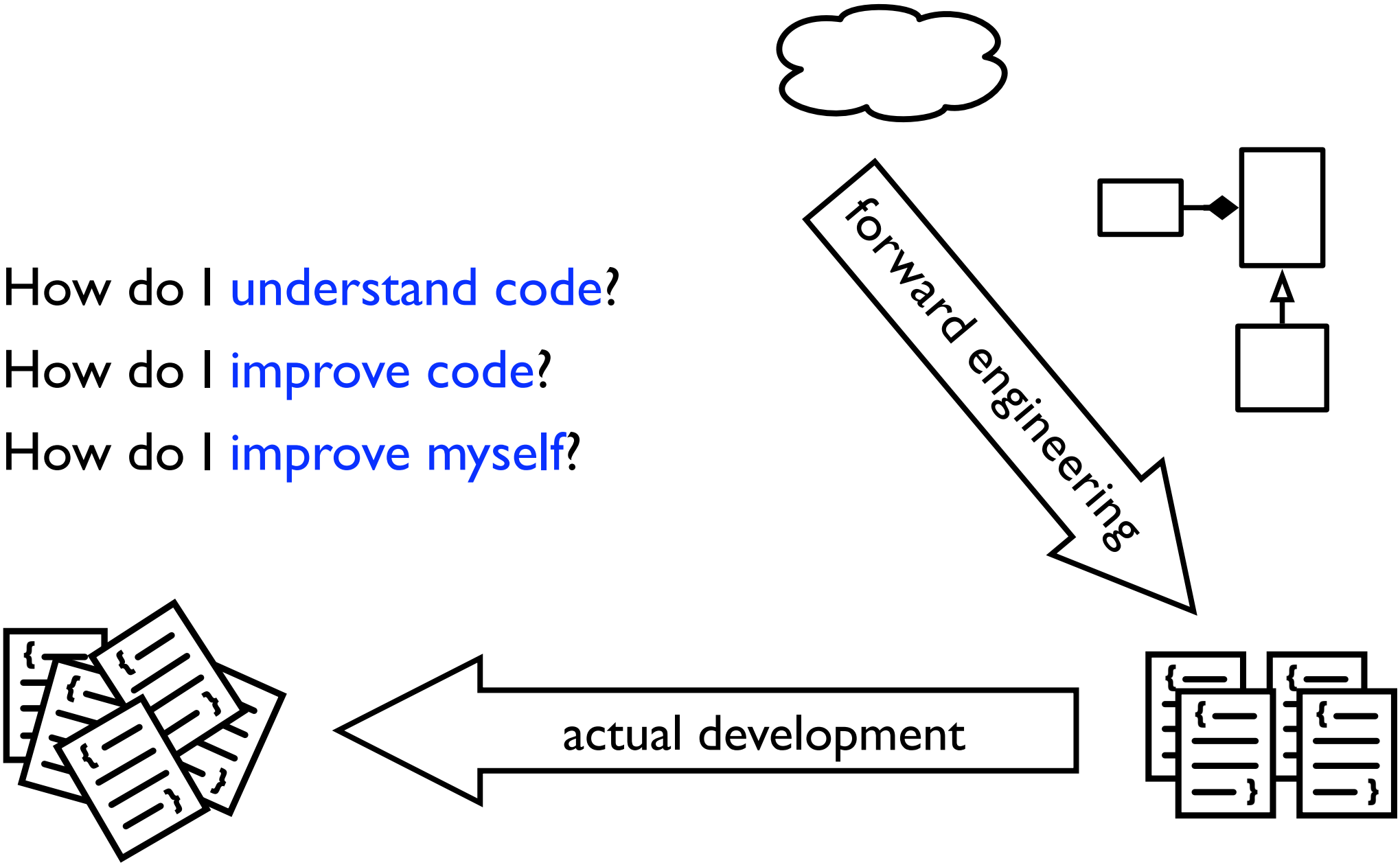
Can metrics help me

in what I really care for? :)

How do I understand code?

How do I improve code?

How do I improve myself?

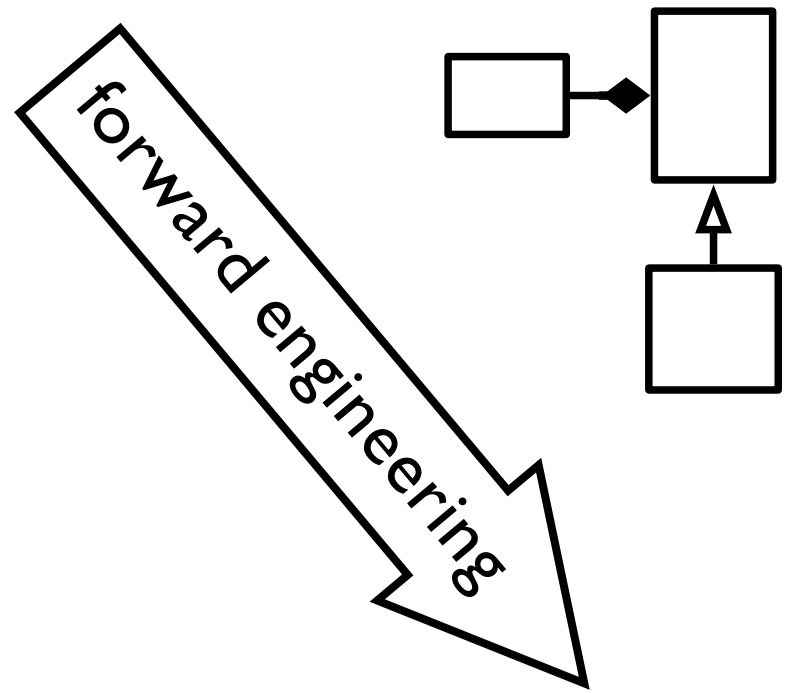


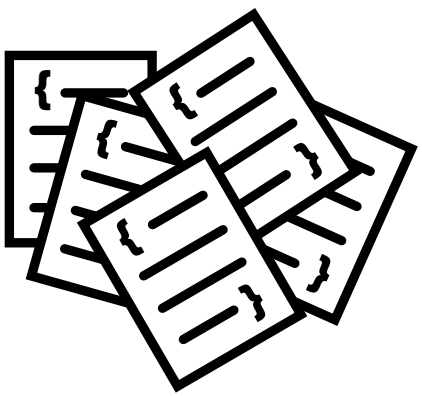
I want nothing to do with metrics!

understand code?

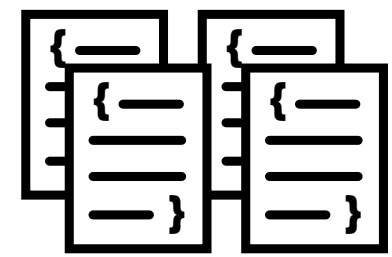
How do I improve code?

How do I improve myself?





actual development



How to get an initial understanding of a system?

Metric	Value
LOC	35175
NOM	3618
NOC	384
CYCLO	5579
NOP	19
CALLS	15128
FANOUT	8590
AHH	0.12
ANDC	0.31

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Metric	Value
LOC	35175
NOM	3618
NOC	384
CYCLO	5579
NOP	18
CALLS	
FANOUT	
AHH	
	0.31

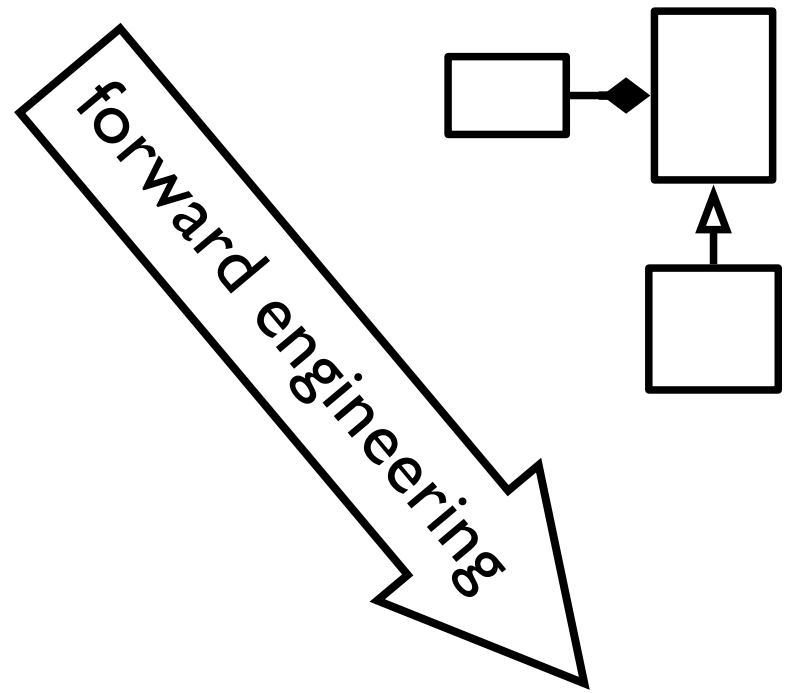
And now what?

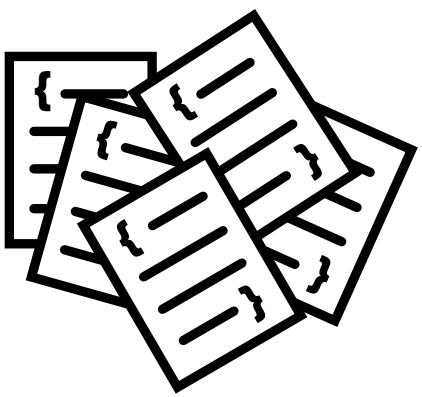
I want nothing to do with metrics!

understand code?

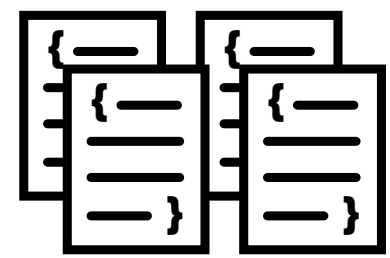
How do I improve code?

How do I improve myself?





actual development



How do I improve code?

Quality is more than 0 bugs.

Breaking design principles, rules and best practices

deteriorates the code;

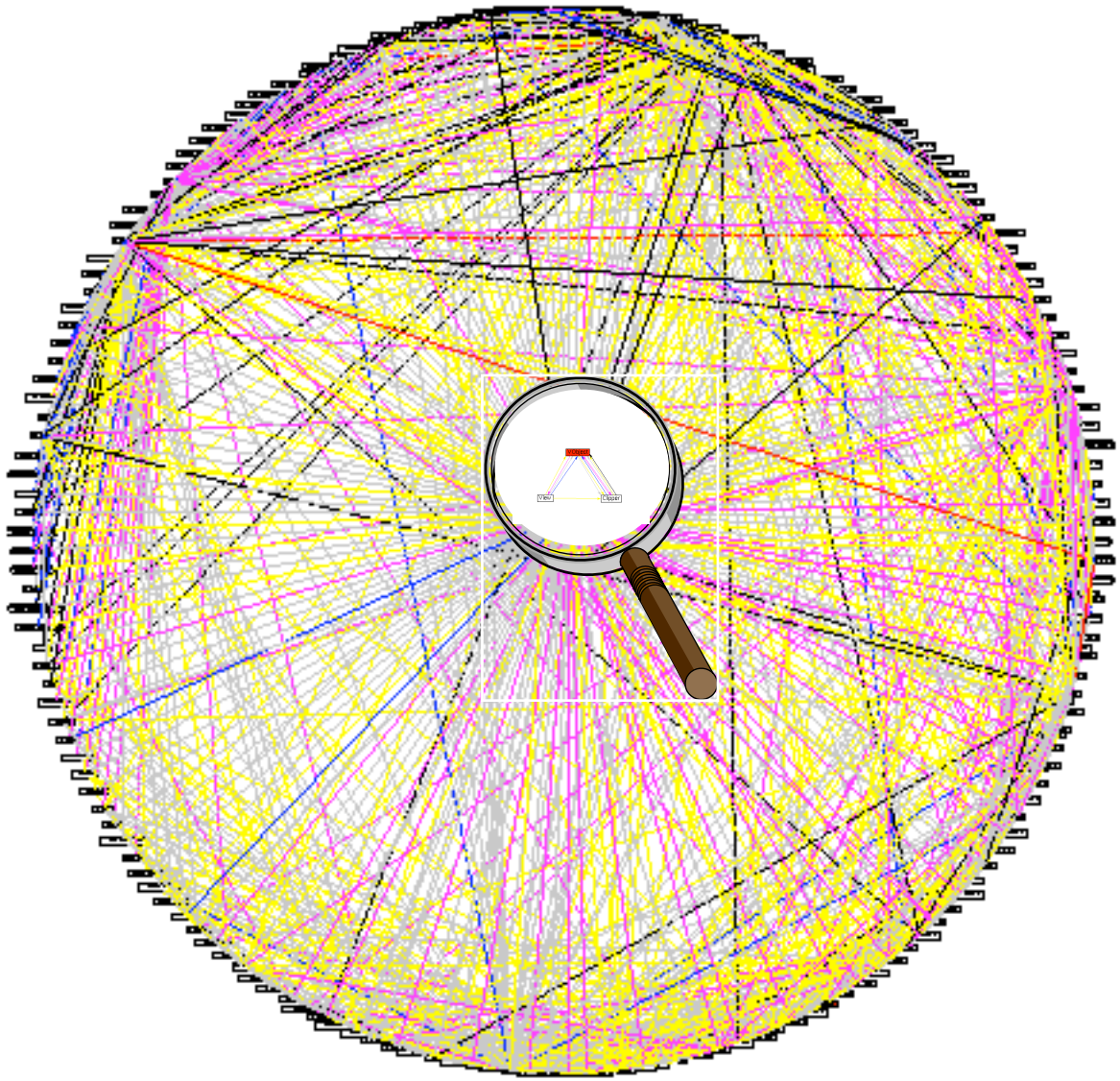
it leads to design problems.

Imagine changing just a small design fragment

and 33%

of all classes

would require changes

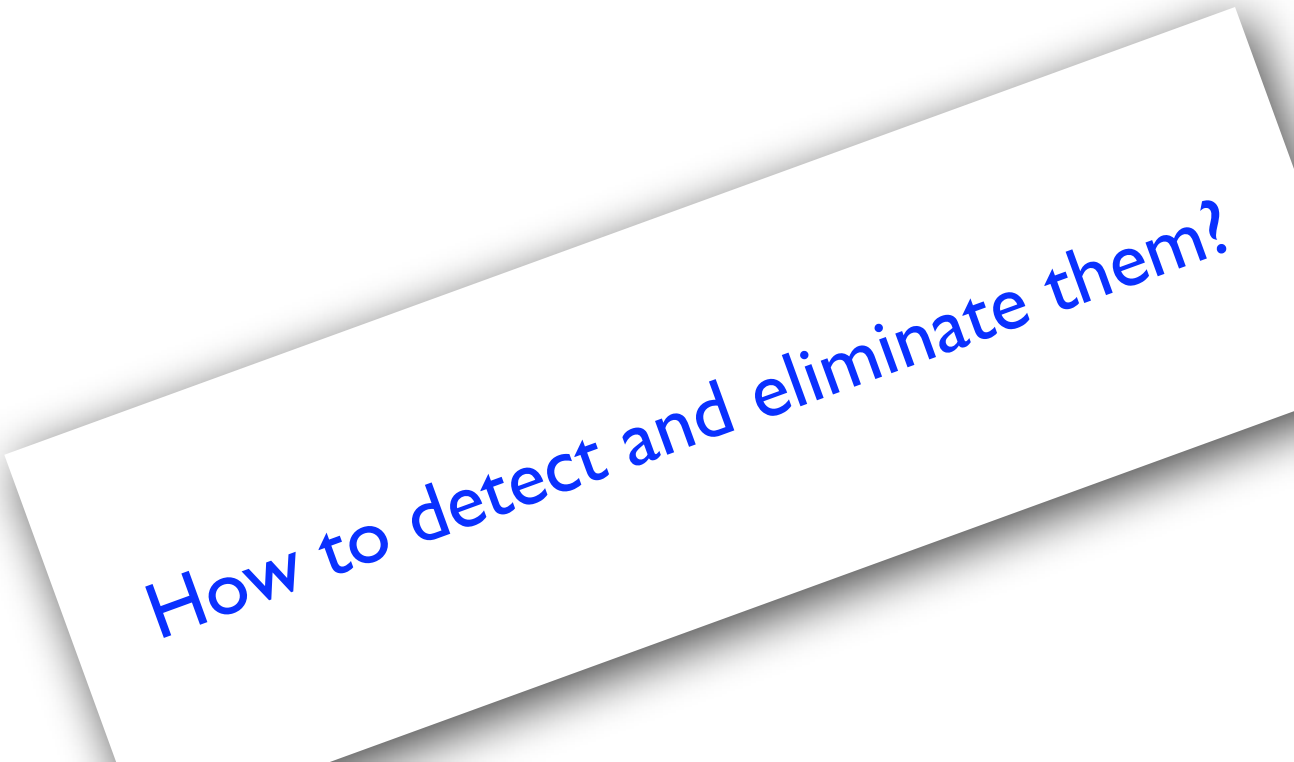


Design problems are

expensive

frequent

unavoidable



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

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,

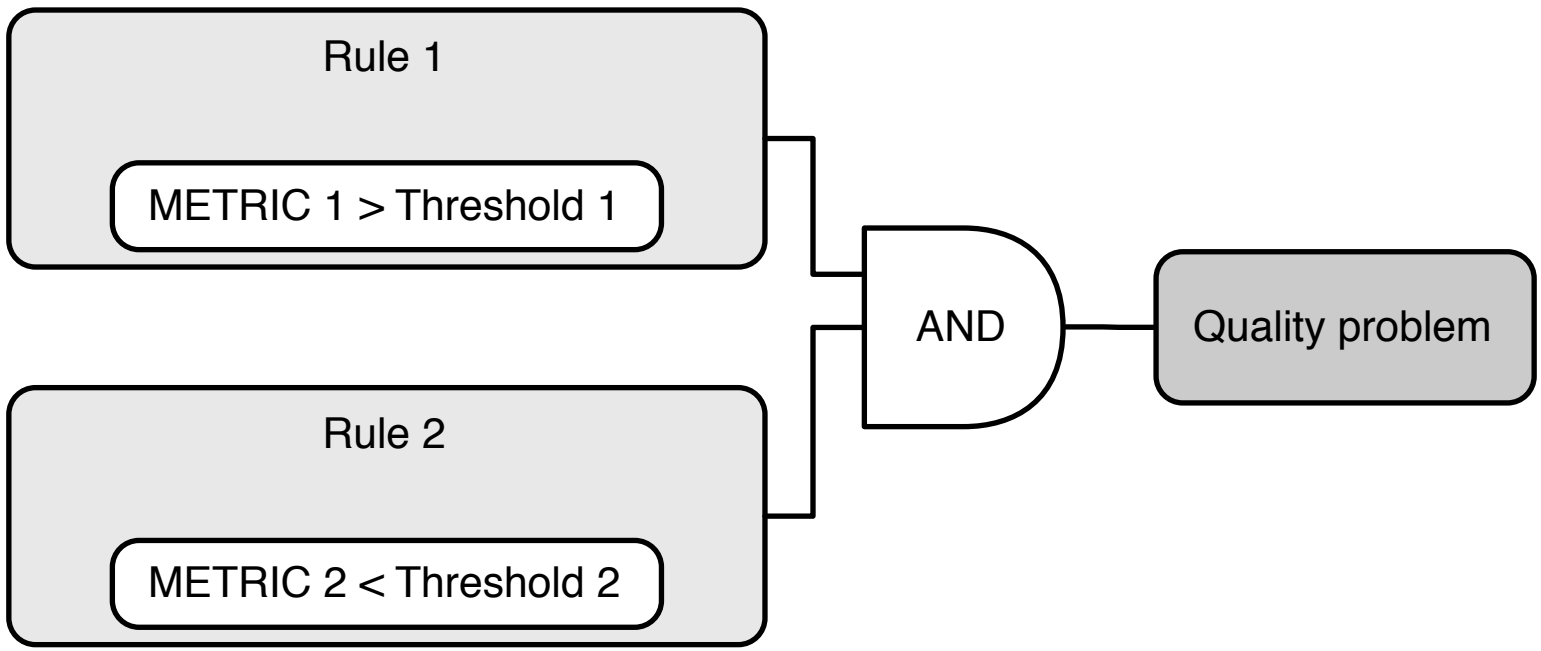
are not cohesive,

access external data.

Compose metrics into queries using logical operators

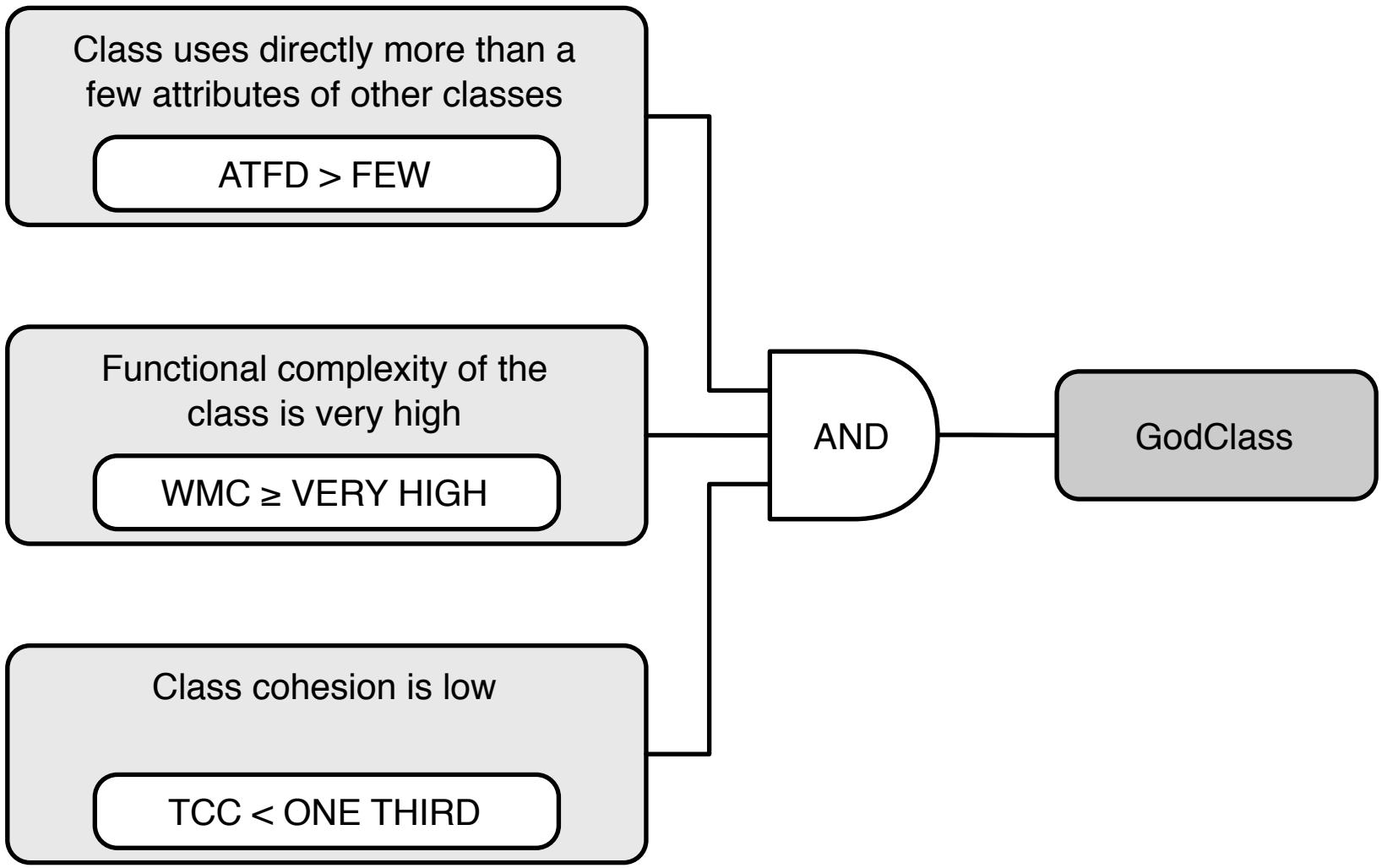
Detection Strategies are metric-based queries to detect design flaws.

Lanza, Marinescu 2006



A God Class centralizes too much intelligence in the system.

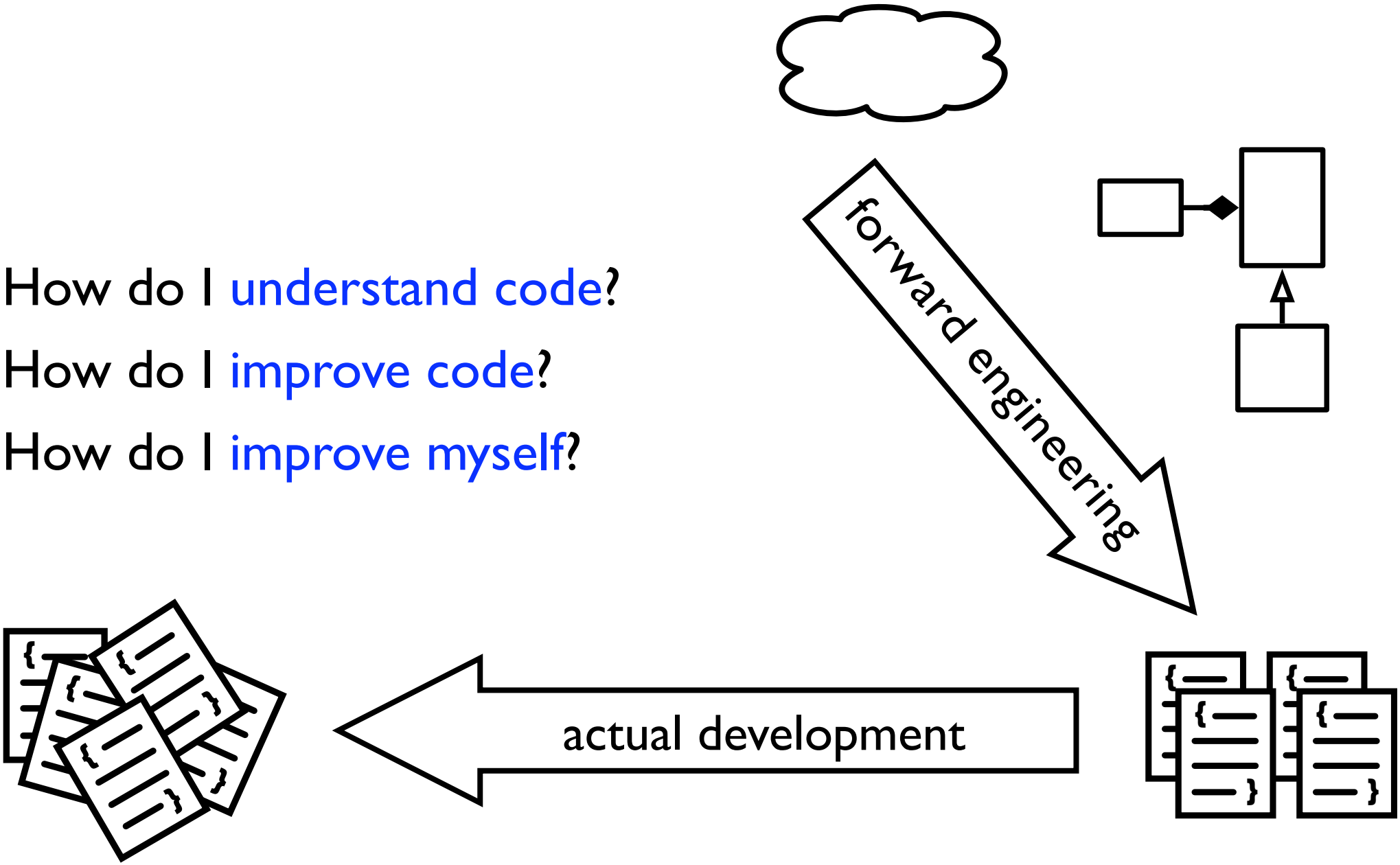
Lanza, Marinescu 2006



How do I understand code?

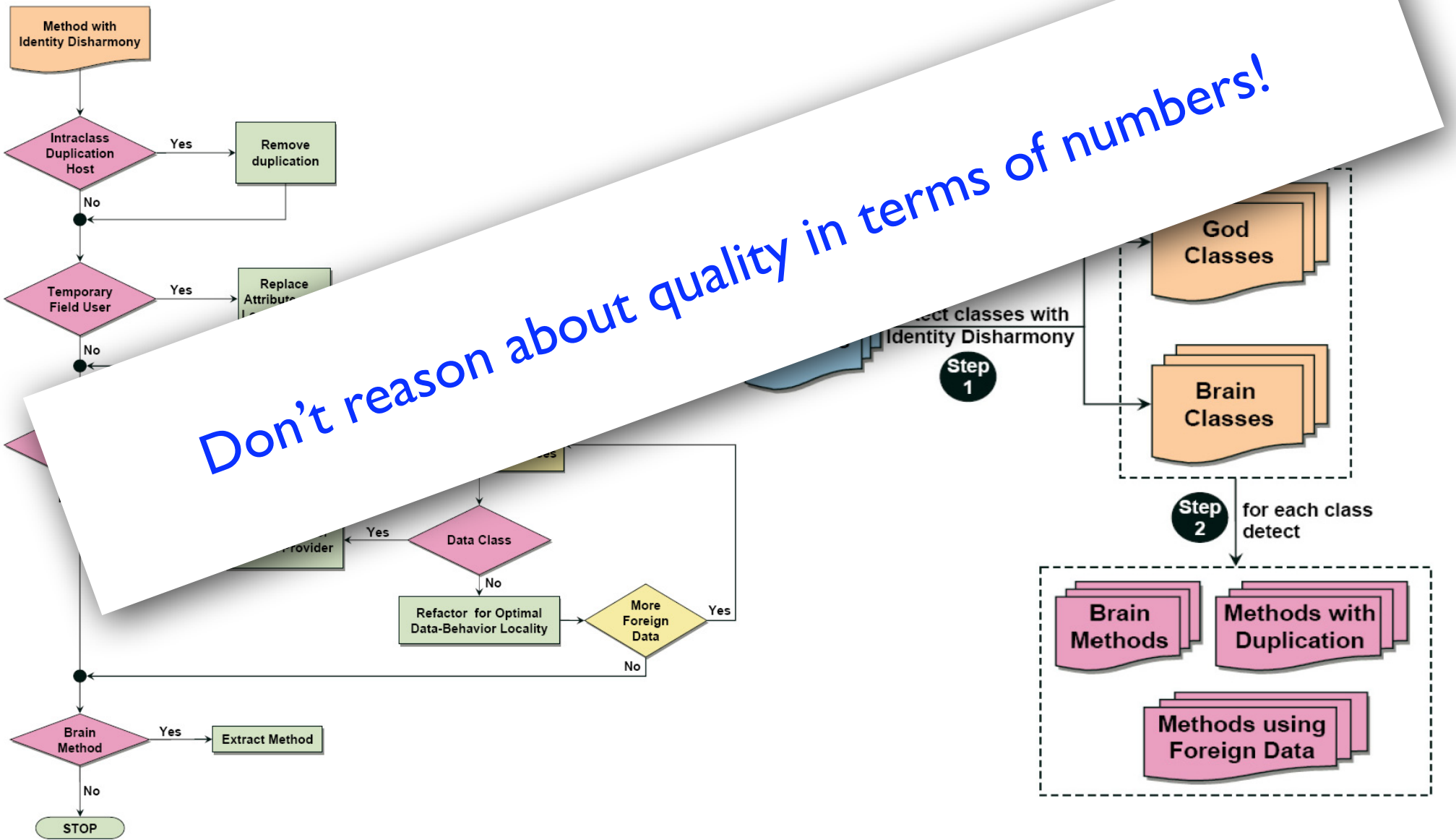
How do I improve code?

How do I improve myself?



How do I improve myself?

Follow a clear and repeatable process



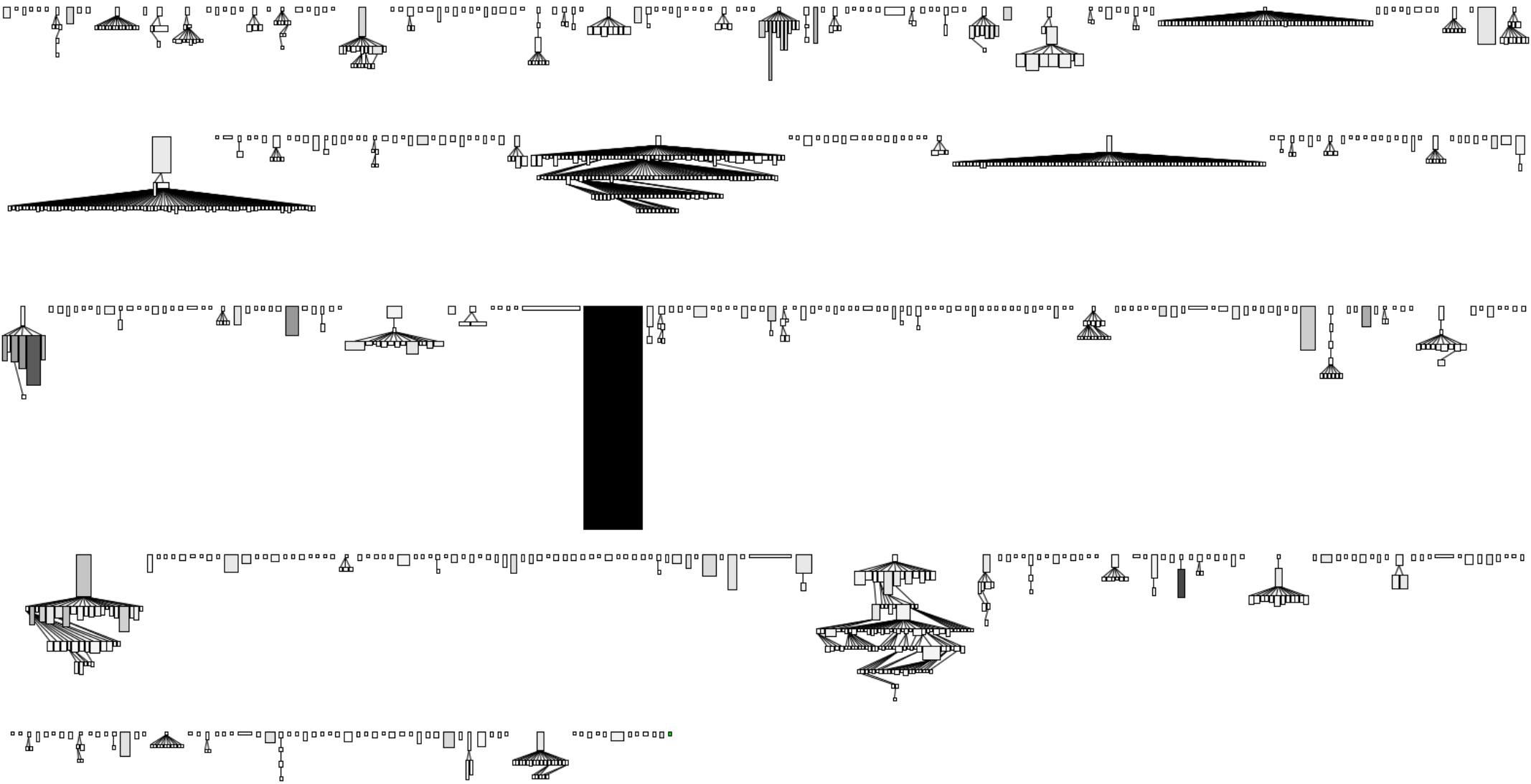
Software in pictures

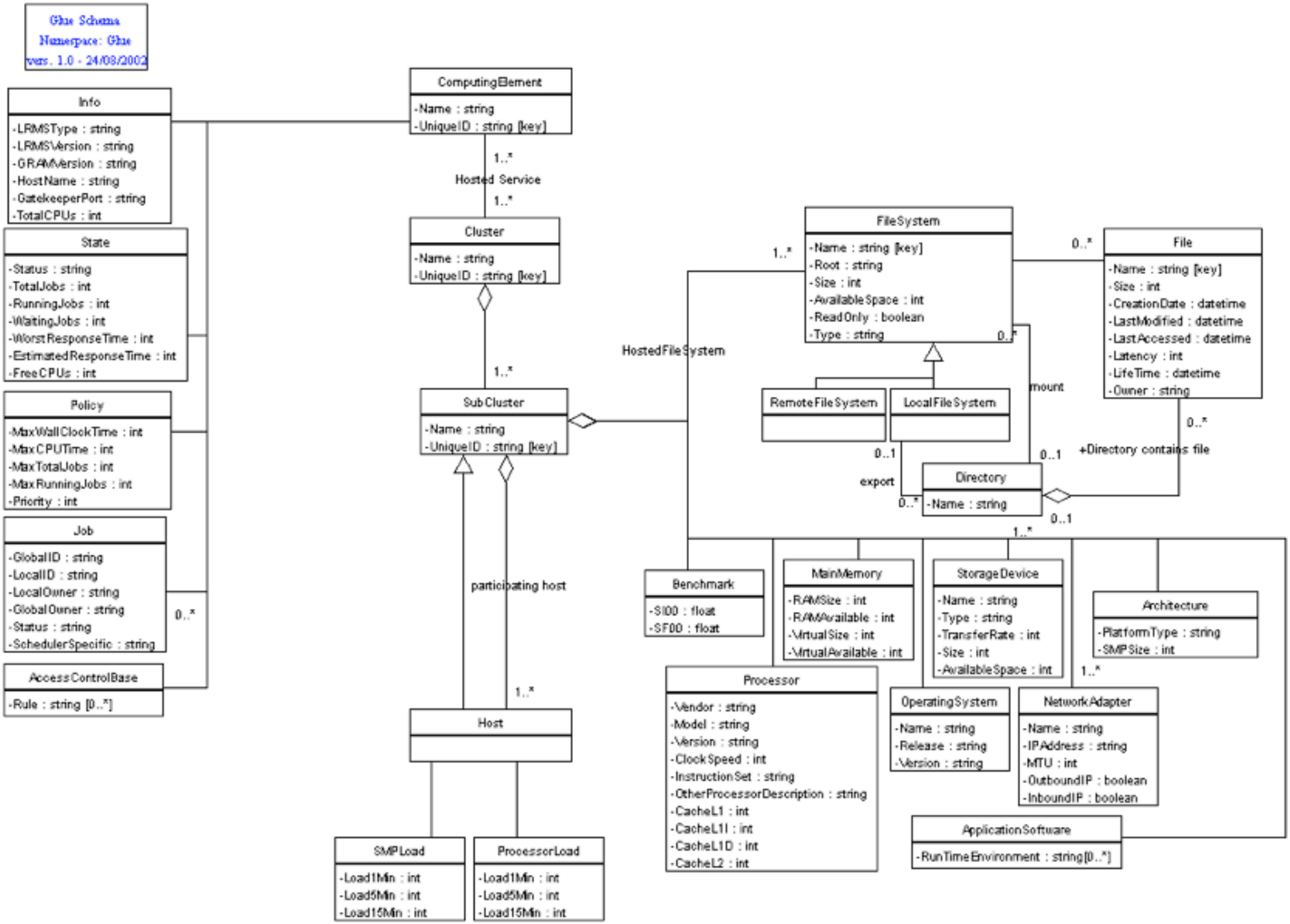
1854, London, cholera epidemic

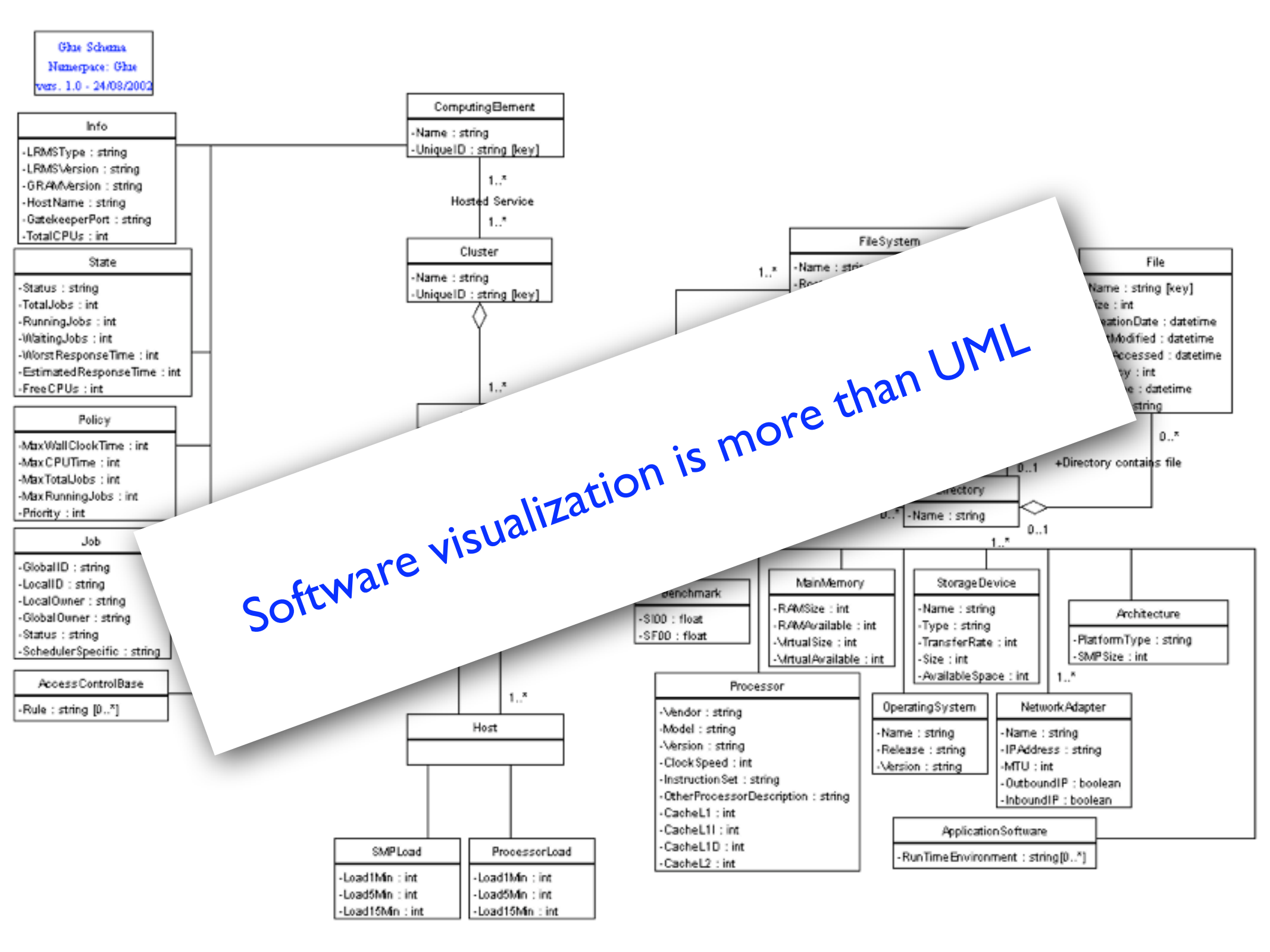
Numbers..

Metric	Value	Remarks
No. of Lines of Code	223,068	including comments
No. of Source Files	1,209	*.java files
No. of Packages	99	–
No. of Classes	1,393	including 140 inner classes
No. of Methods	9,561	including accessor methods
No. of Attributes	3,358	all variables including static and local variables

Visualization compresses the system into pictures.




Glue Schema
Namespace: Glue
vers. 1.0 - 24/08/2002
Info
-LRMSType : string
-LRMSVersion : string
-GRAMVersion : string
-HostName : string
-GatekeeperPort : string
-TotalCPUs : int
State
-Status : string
-TotalJobs : int
-RunningJobs : int
-WaitingJobs : int
-WorstResponseTime : int
-EstimatedResponseTime : int
-FreeCPUs : int
Policy
-MaxWallClockTime : int
-MaxCPUTime : int
-MaxTotalJobs : int
-MaxRunningJobs : int
-Priority : int
Job
-GlobalID : string
-LocalID : string
-LocalOwner : string
-GlobalOwner : string
-Status : string
-SchedulerSpecific : string
AccessControlBase
-Rule : string [0..*]
0..*
ComputingElement
-Name : string
-UniqueID : string [key]
1..*
Hosted Service
1..*
Cluster
-Name : string
-UniqueID : string [key]
1..*
SubCluster
-Name : string
-UniqueID : string [key]
participating host
1..*
Host
SMPLoad
-Load1Min : int
-Load5Min : int
-Load15Min : int
ProcessorLoad
-Load1Min : int
-Load5Min : int
-Load15Min : int
HostedFileSystem
1..*
FileSystem
-Name : string [key]
-Root : string
-Size : int
-AvailableSpace : int
-ReadOnly : boolean
-Type : string
0..*
RemoteFileSystem
LocalFileSystem
0..1
export
0..*
mount
0..1
Directory
-Name : string
0..1
1..*
0..*
File
-Name : string [key]
-Size : int
-CreationDate : datetime
-LastModified : datetime
-LastAccessed : datetime
-Latency : int
-LifeTime : datetime
-Owner : string
0..*
+Directory contains file
Benchmark
-SI00 : float
-SF00 : float
MainMemory
-RAMSize : int
-RAMAvailable : int
-VirtualSize : int
-VirtualAvailable : int
StorageDevice
-Name : string
-Type : string
-TransferRate : int
-Size : int
-AvailableSpace : int
Architecture
-PlatformType : string
-SMPSize : int
1..*
Processor
-Vendor : string
-Model : string
-Version : string
-ClockSpeed : int
-InstructionSet : string
-OtherProcessorDescription : string
-CacheL1 : int
-CacheL1I : int
-CacheL1D : int
-CacheL2 : int
OperatingSystem
-Name : string
-Release : string
-Version : string
NetworkAdapter
-Name : string
-IPAddress : string
-MTU : int
-OutboundIP : boolean
-InboundIP : boolean
ApplicationSoftware
-RunTimeEnvironment : string[0..*]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File
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0..*
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-CacheL1I : int
-CacheL1D : int
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-Version : string
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-MTU : int
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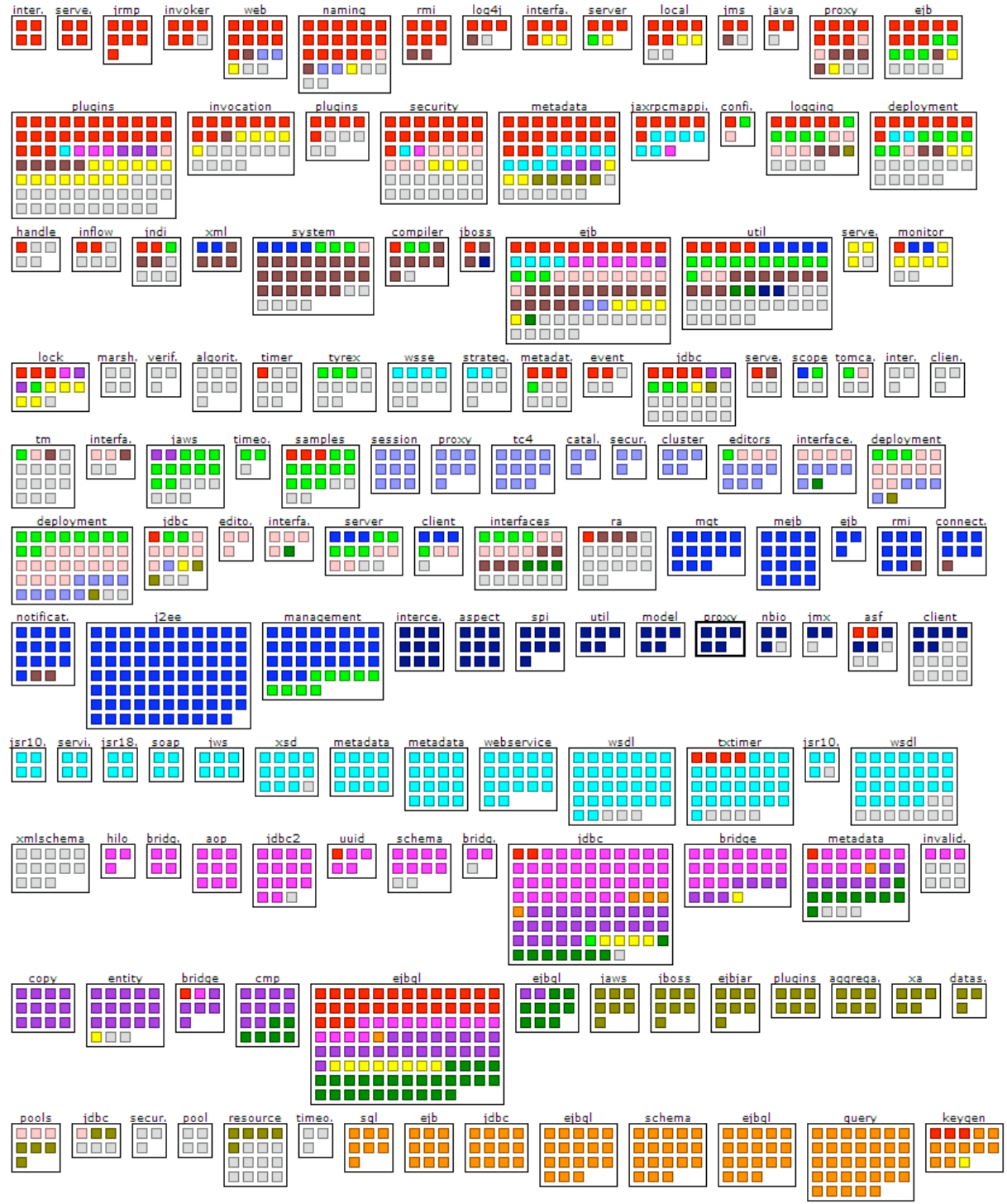
-InboundIP : boolean
ApplicationSoftware
-RunTimeEnvironment : string[0..*]
Software visualization is more than UML

We are

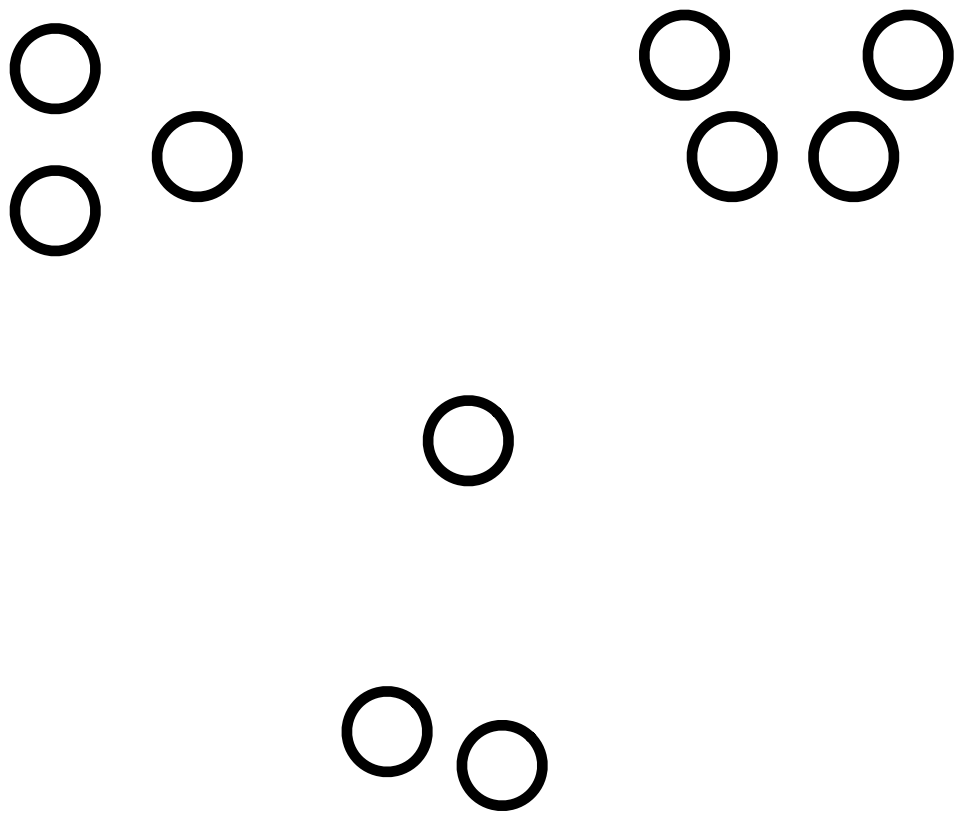
visual

beings ...

... and we're good at spotting patterns



How many groups do you see?



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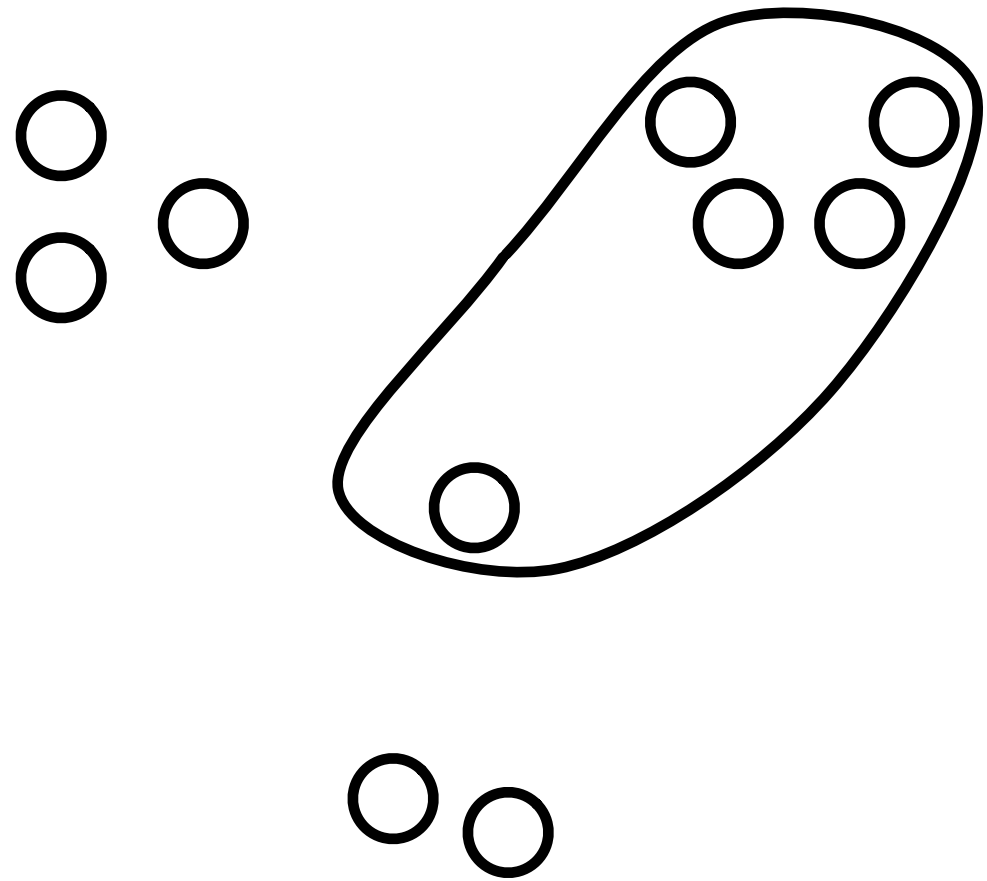

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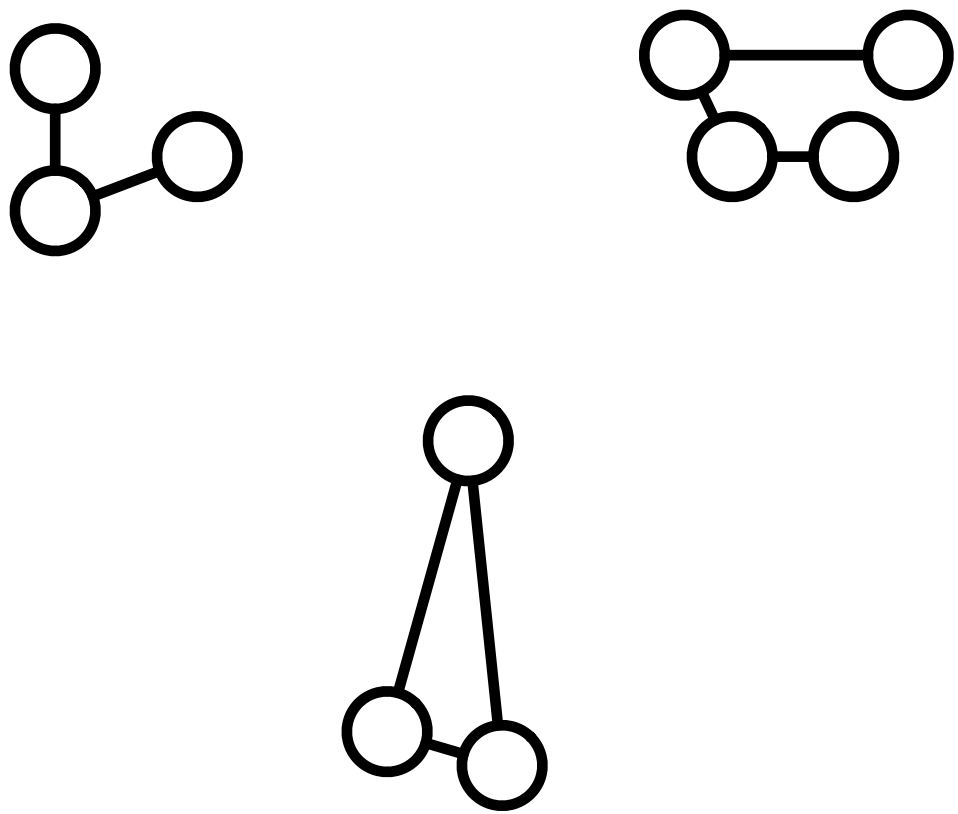

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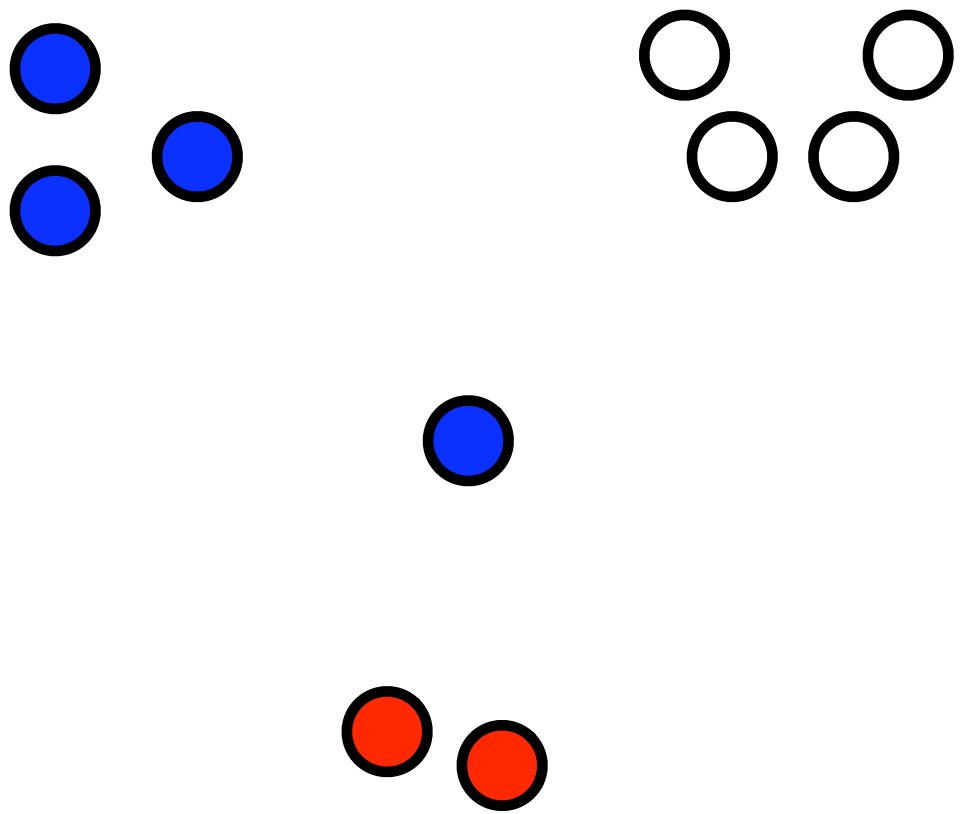
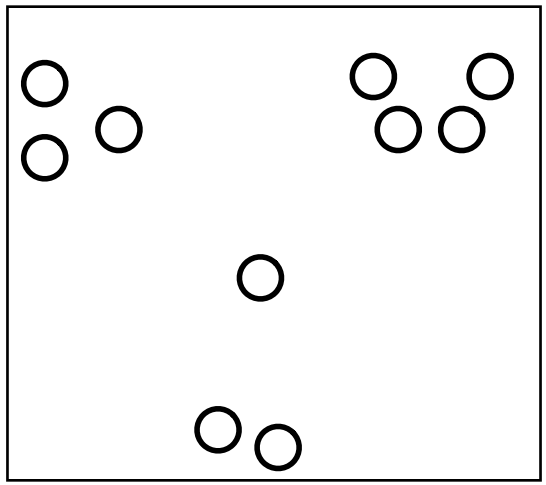
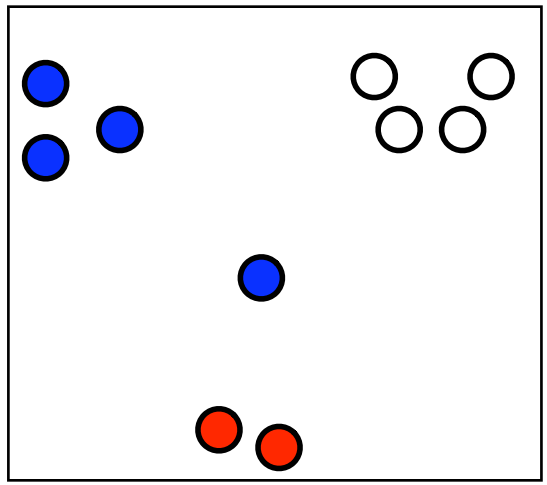


Gestalt principles

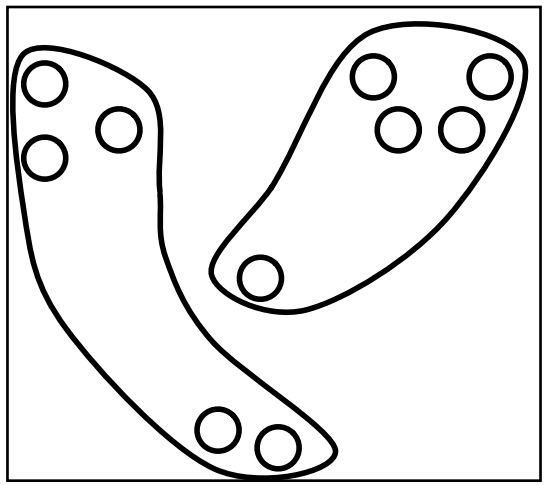
proximity



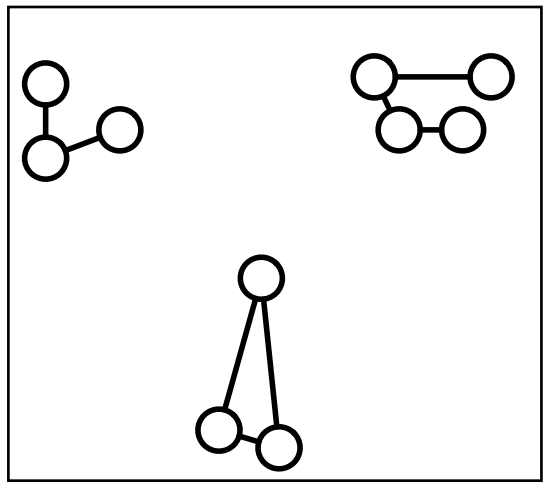
similarity



enclosure



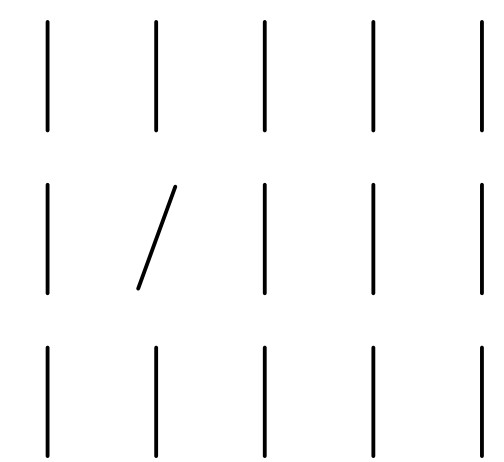
connectivity



Attributes of Form

Orientation	Line Length	Line Width	Size
Shape	Curvature	Added Marks	Enclosure

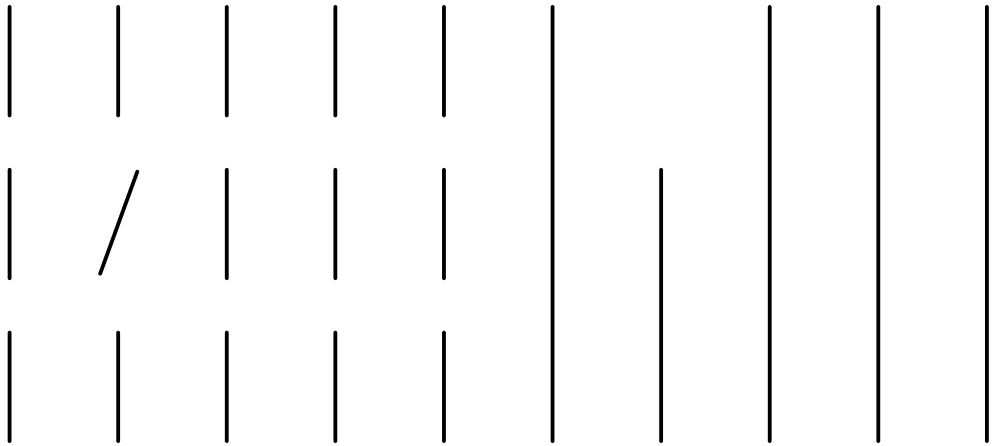
Attributes of Form



Line Length	Line Width	Size

Shape	Curvature	Added Marks	Enclosure

Attributes of Form



Line Width

Size

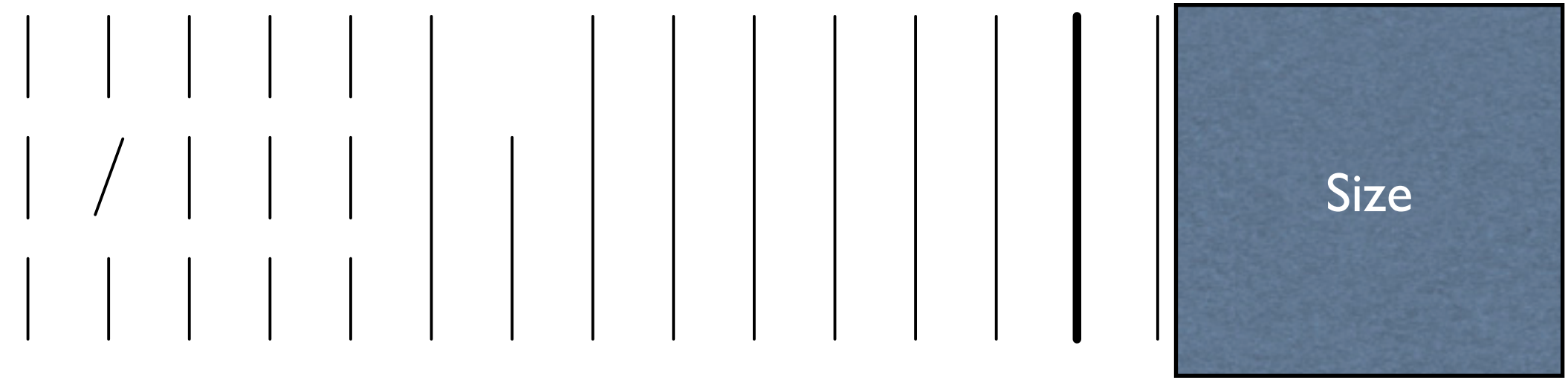
Shape

Curvature

Added Marks

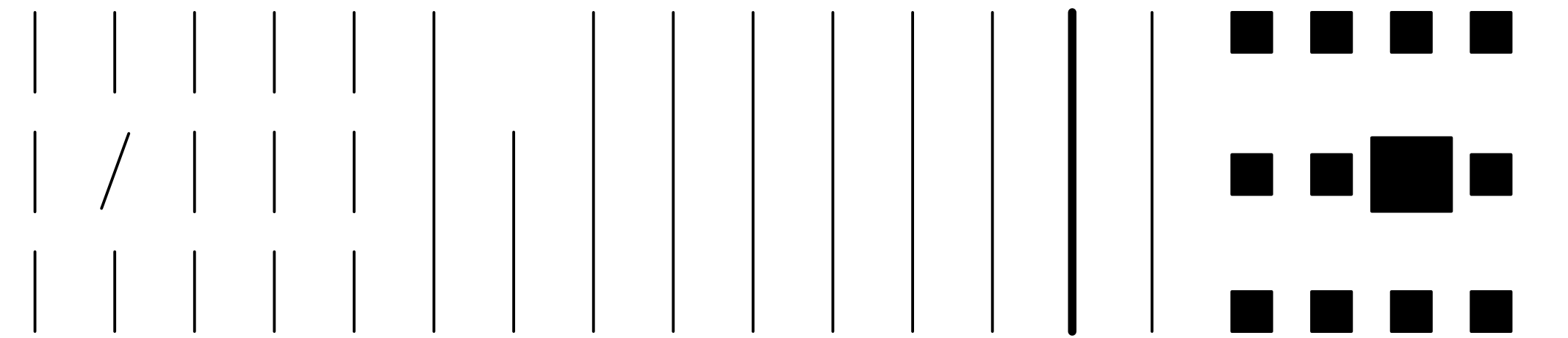
Enclosure

Attributes of Form



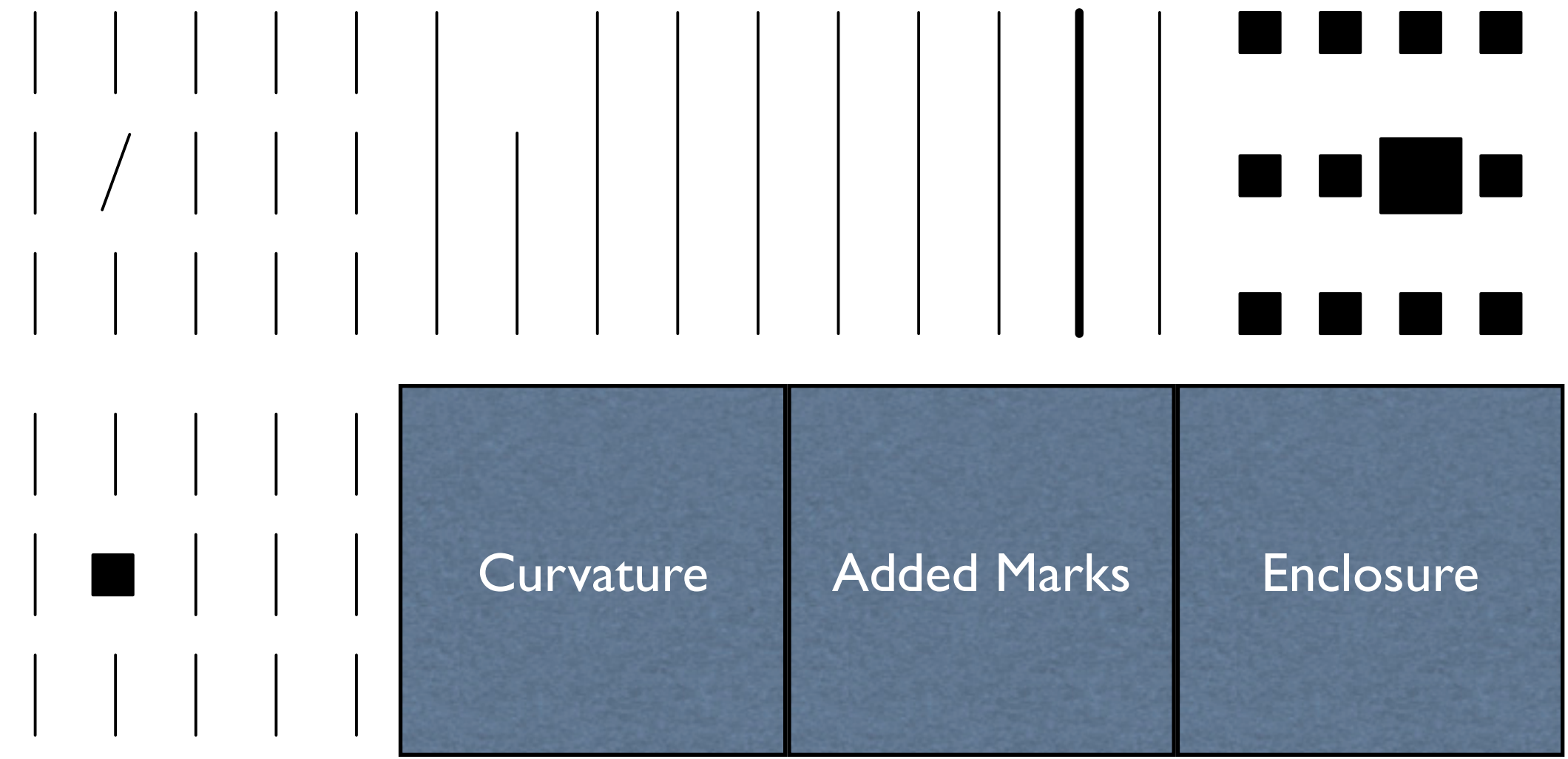
Shape | Curvature | Added Marks | Enclosure

Attributes of Form



Shape	Curvature	Added Marks	Enclosure

Attributes of Form



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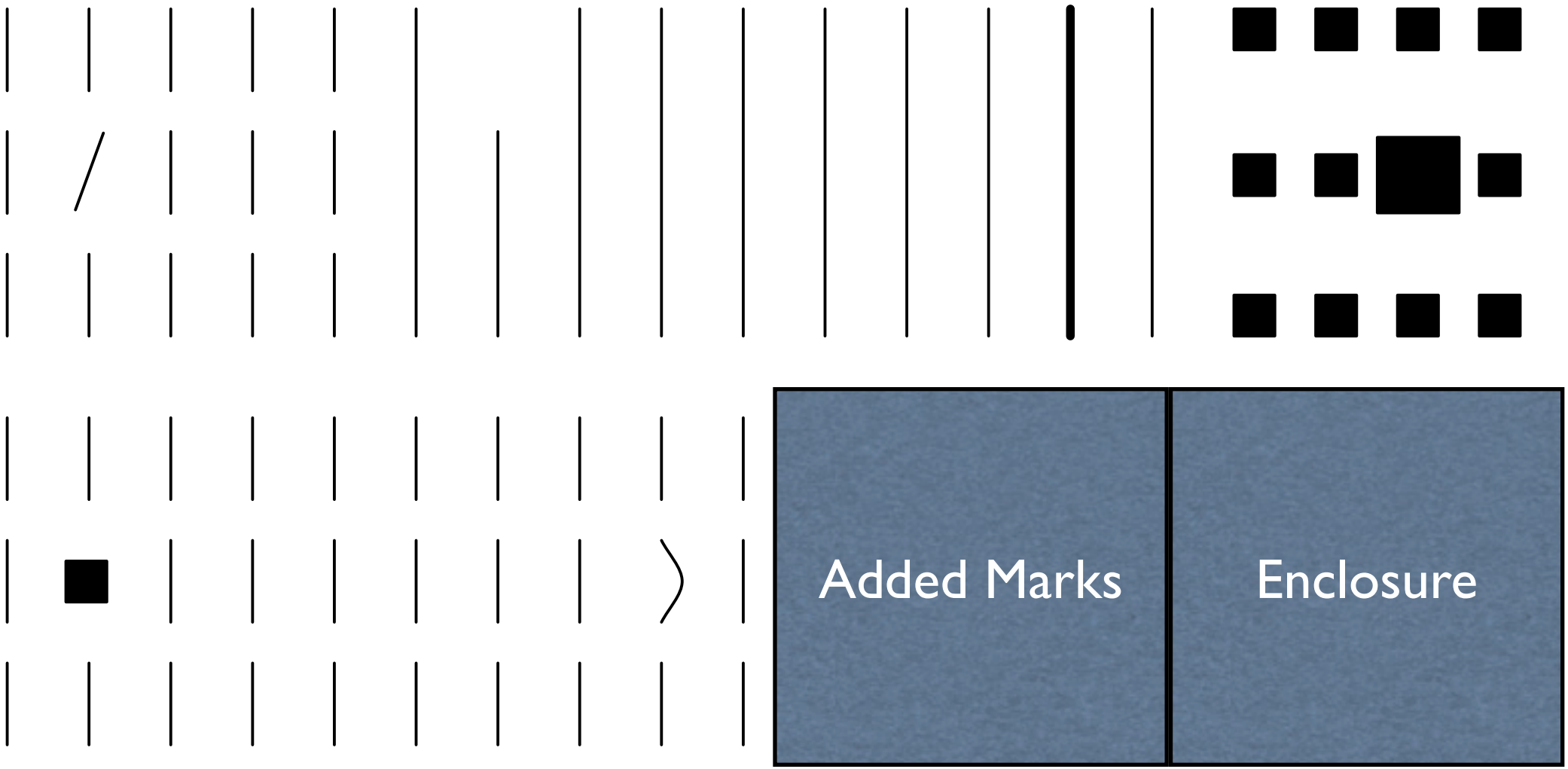

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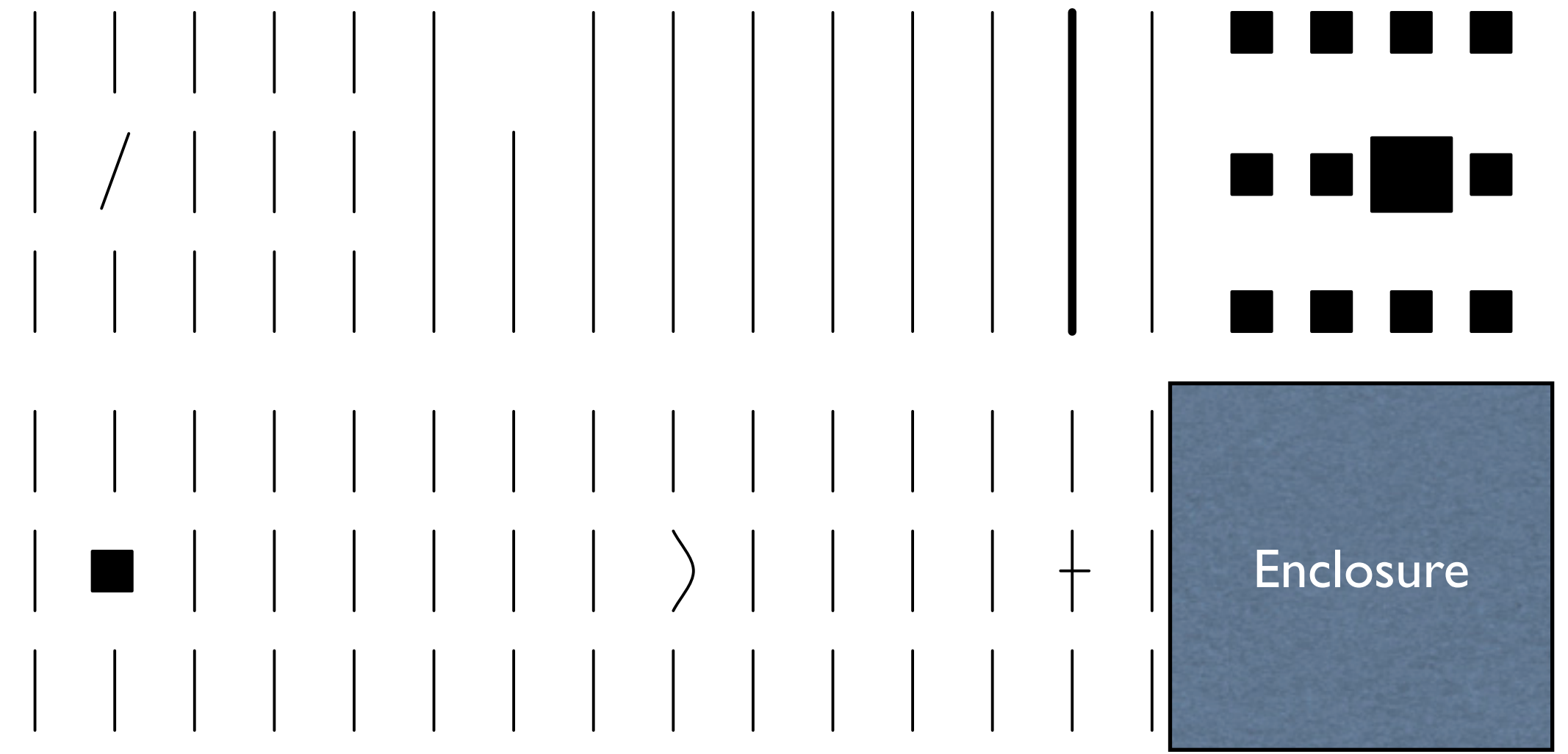

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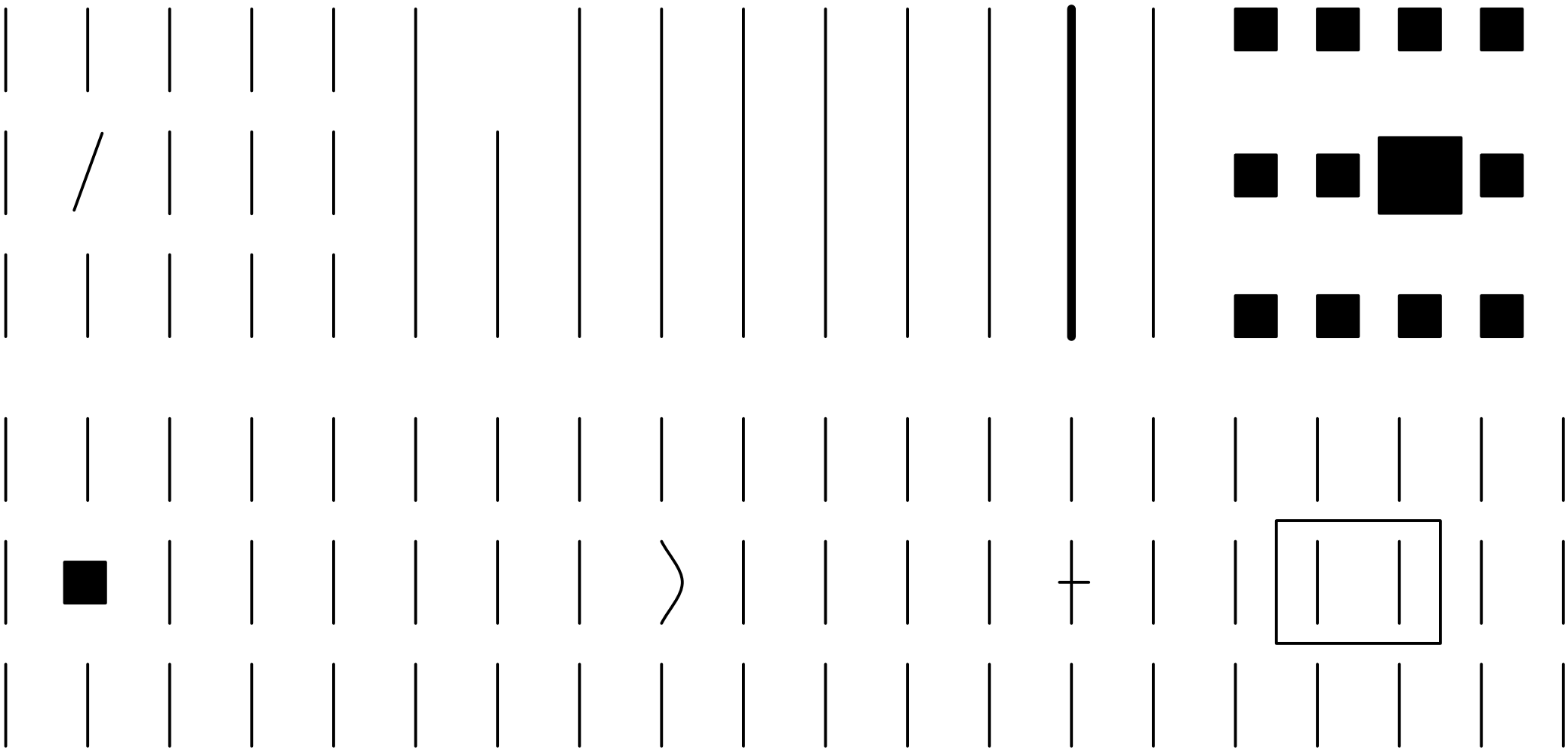


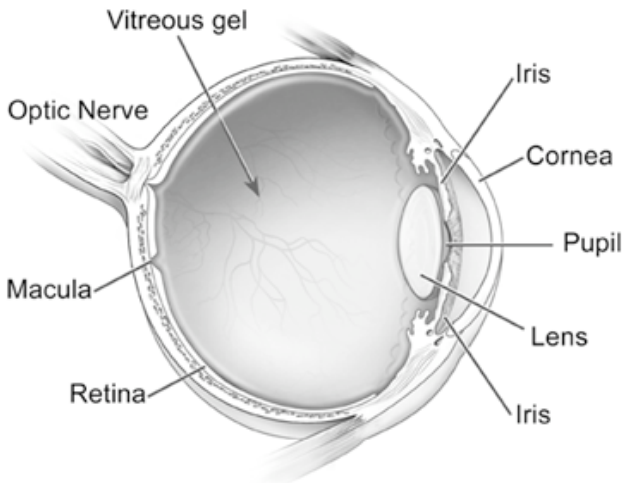
Exemplifying Preattentive Processing

8789364082376403128764532984732984732094873290845
389274-0329874-32874-2319847509834098340983240983 2
049823-0984903281453209481-0839393947896587436598

8789364082376403128764532984732984732094873290845
389274-0329874-32874-2319847509834098340983240983 2
049823-0984903281453209481-0839393947896587436598

70%

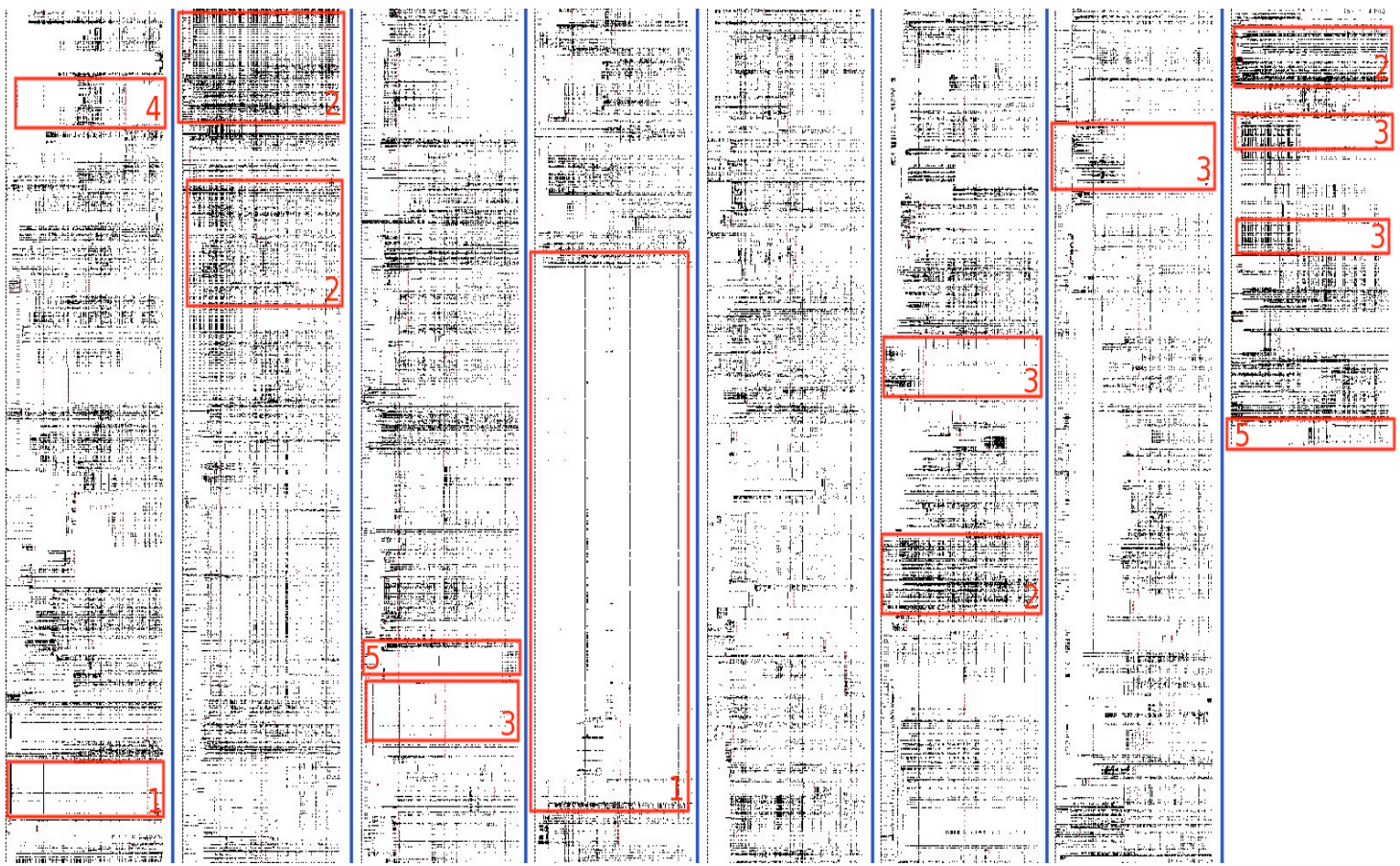
of all external inputs come through the eyes



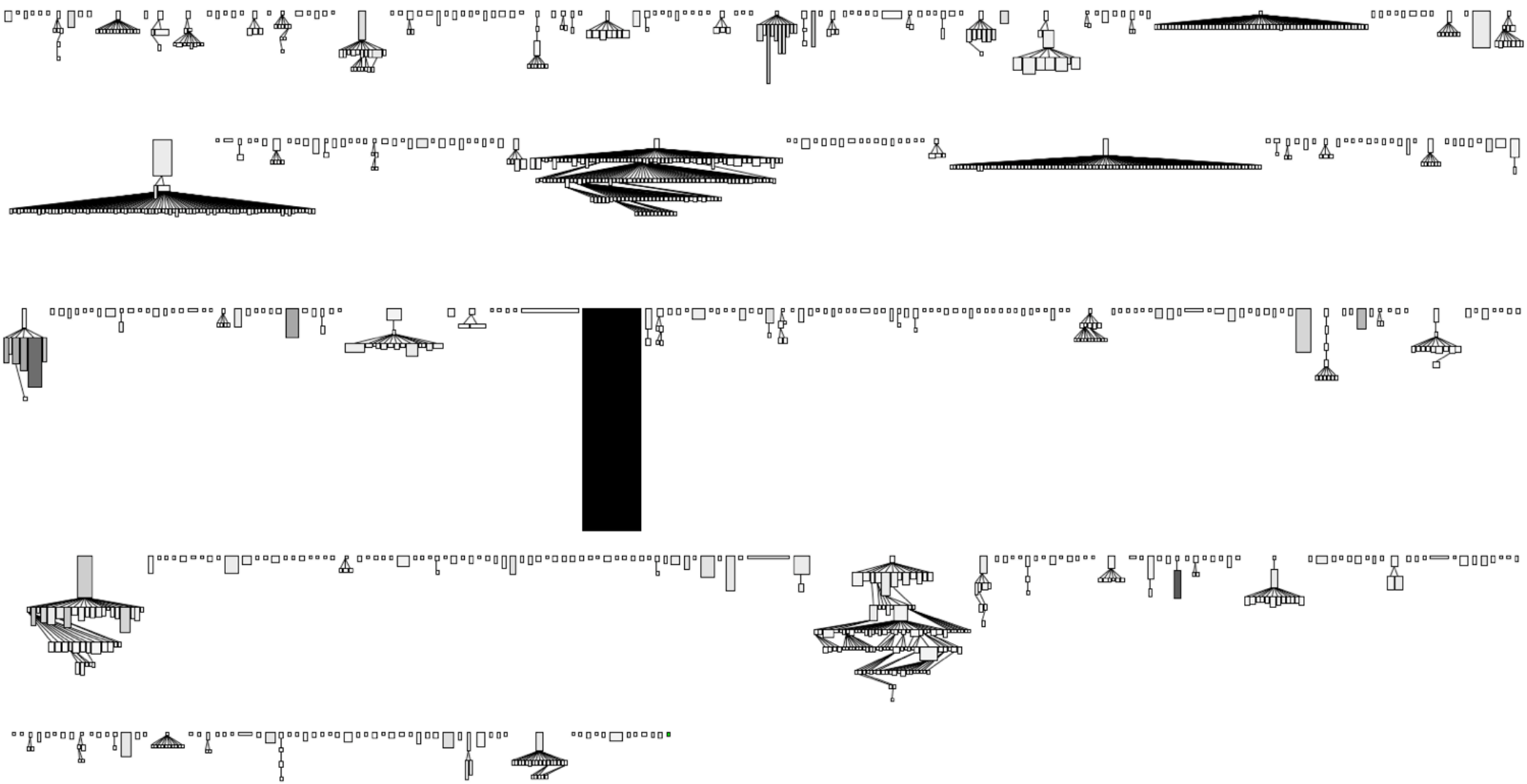
Software visualization is

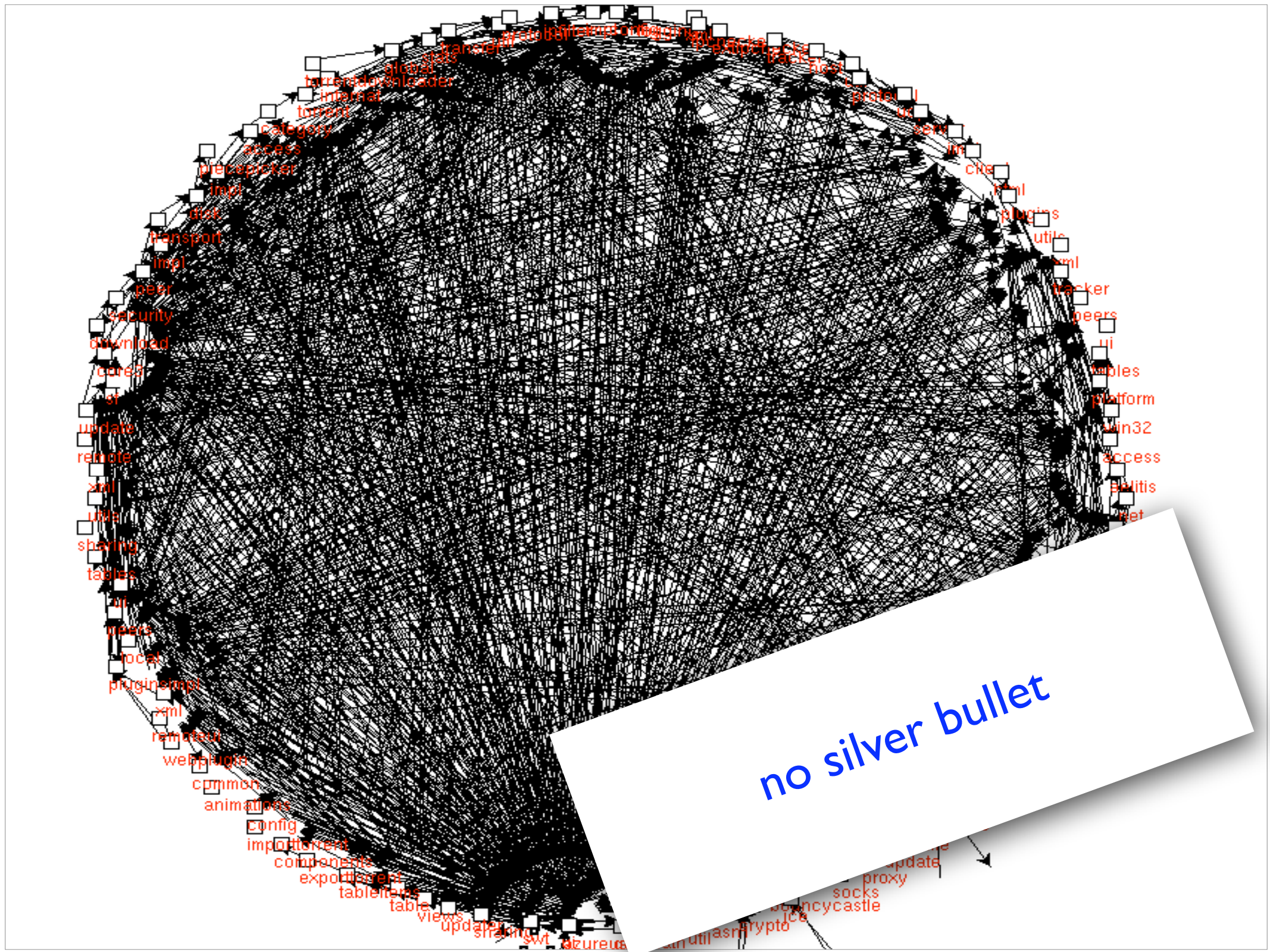
the use of the crafts of typography, graphic design, animation, and cinematography with modern human-computer interaction and computer graphics technology to facilitate both the human understanding and effective use of computer software.

Price, Becker, Small

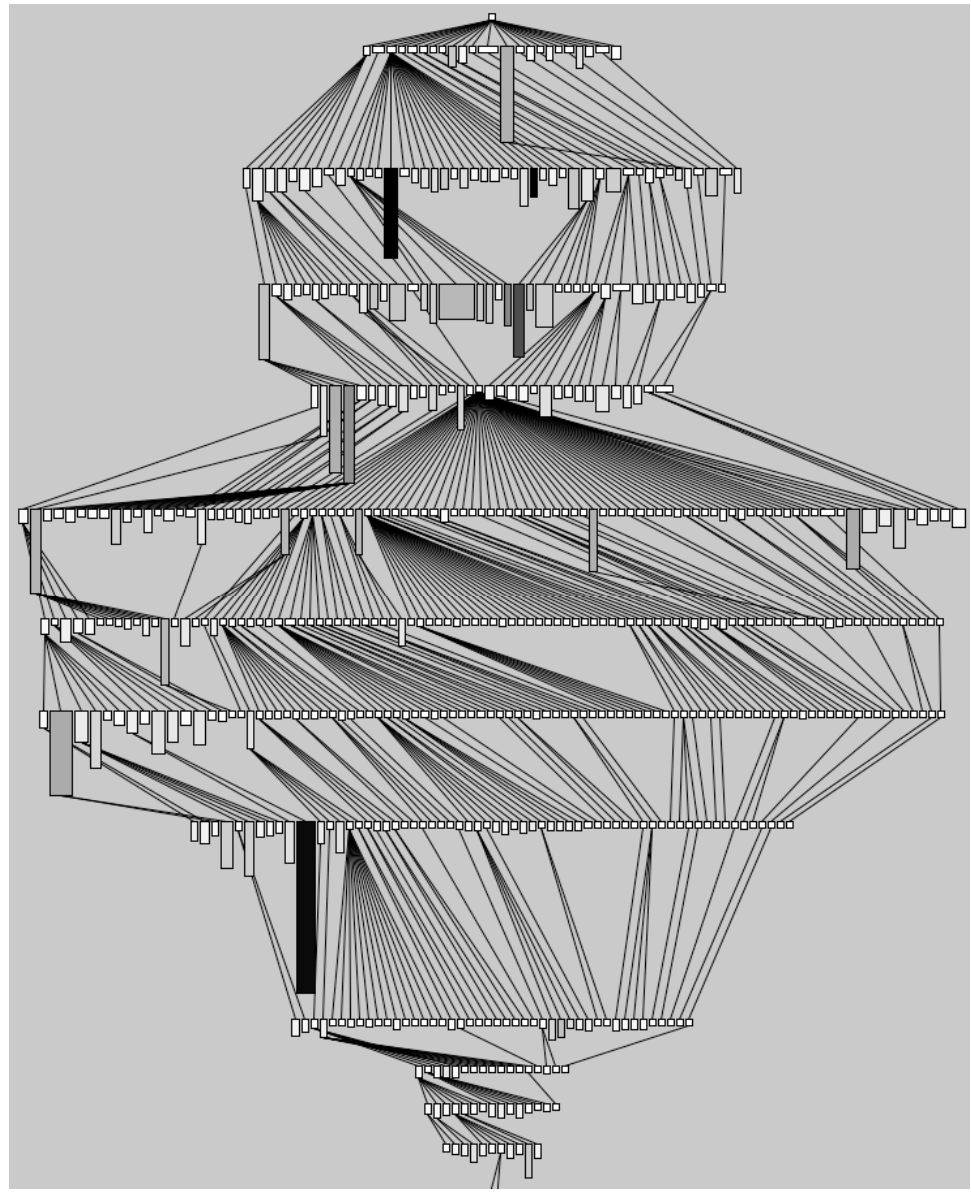


Static Visualization



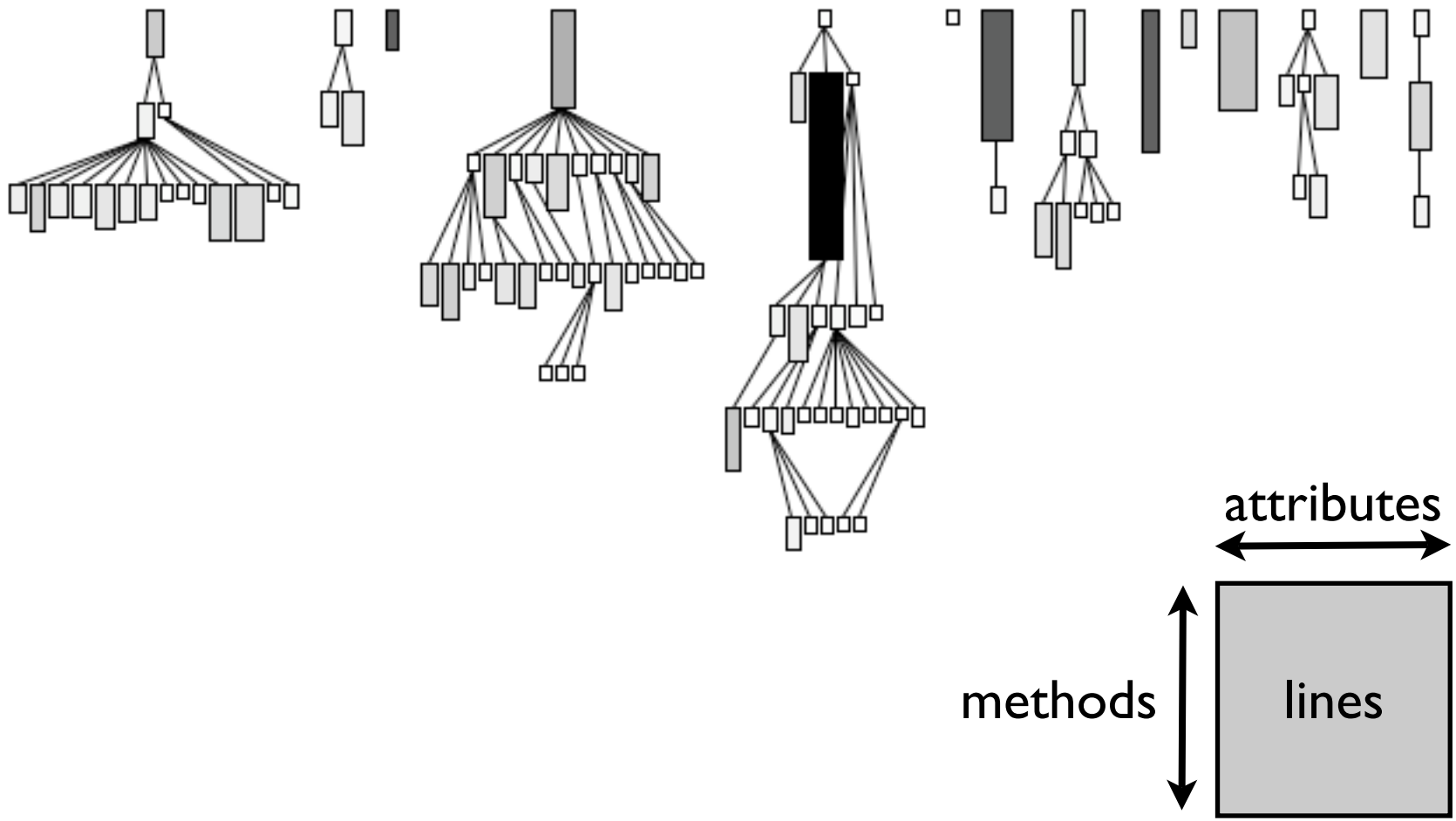

no silver bullet

Software is complex



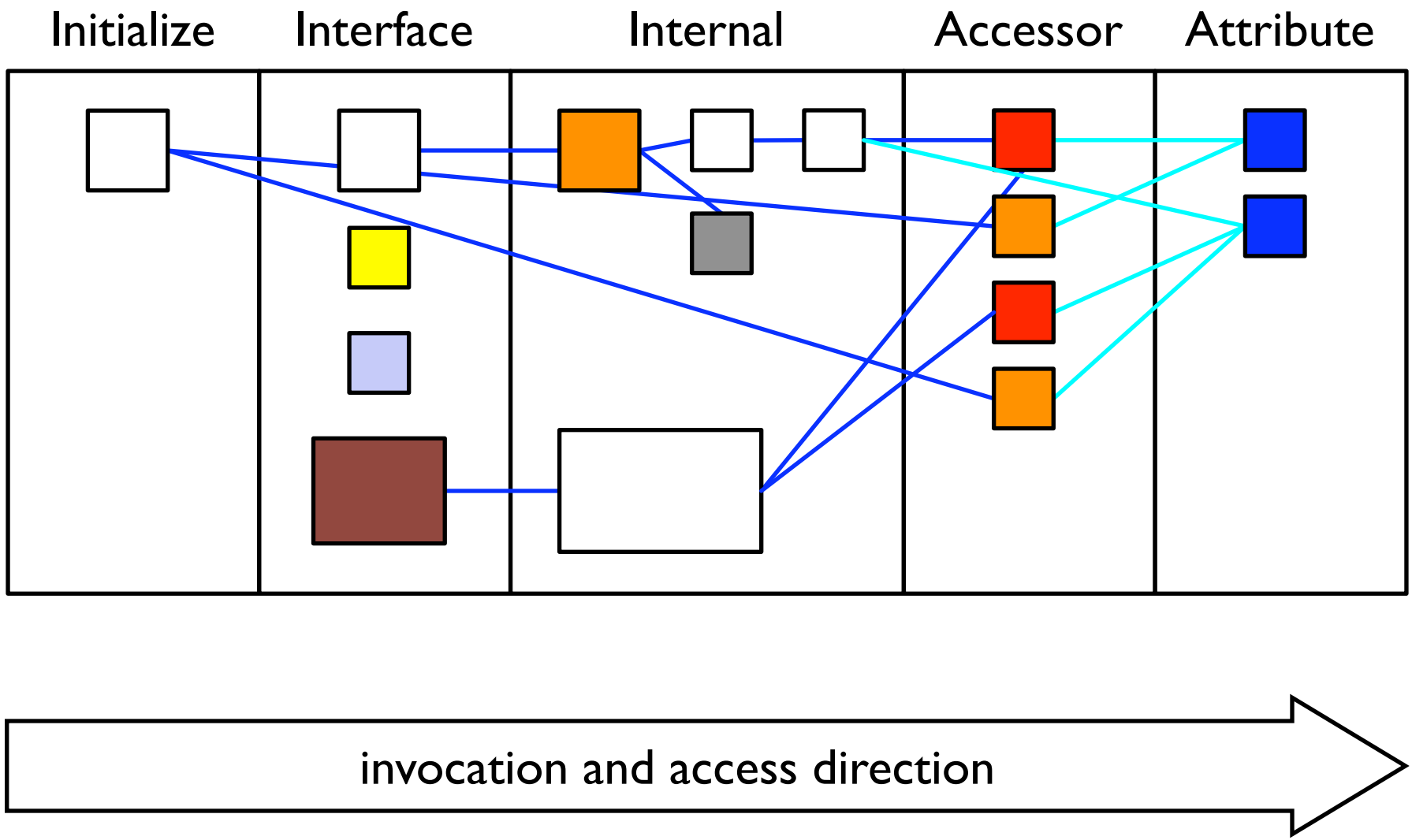
System Complexity shows class hierarchies.

Lanza, Ducasse, 2003

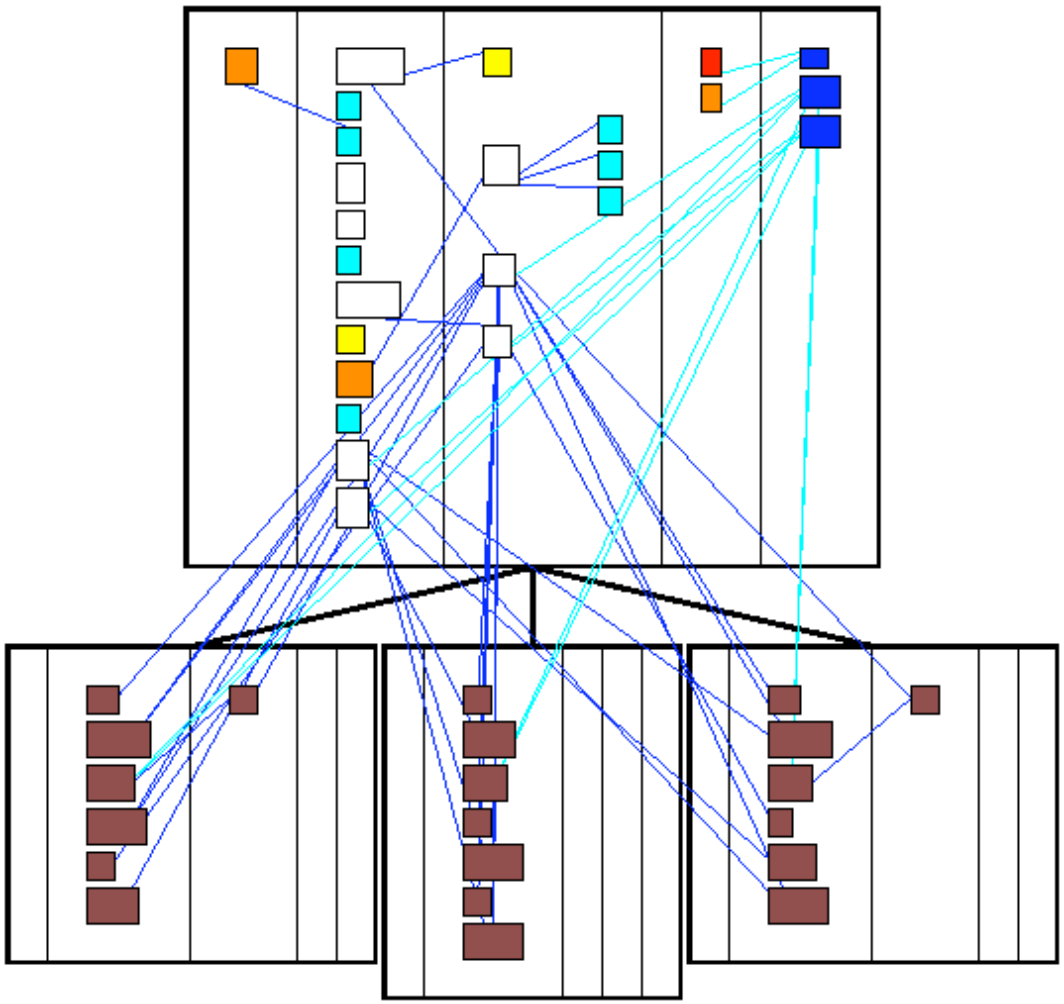


Class Blueprint shows class internals.

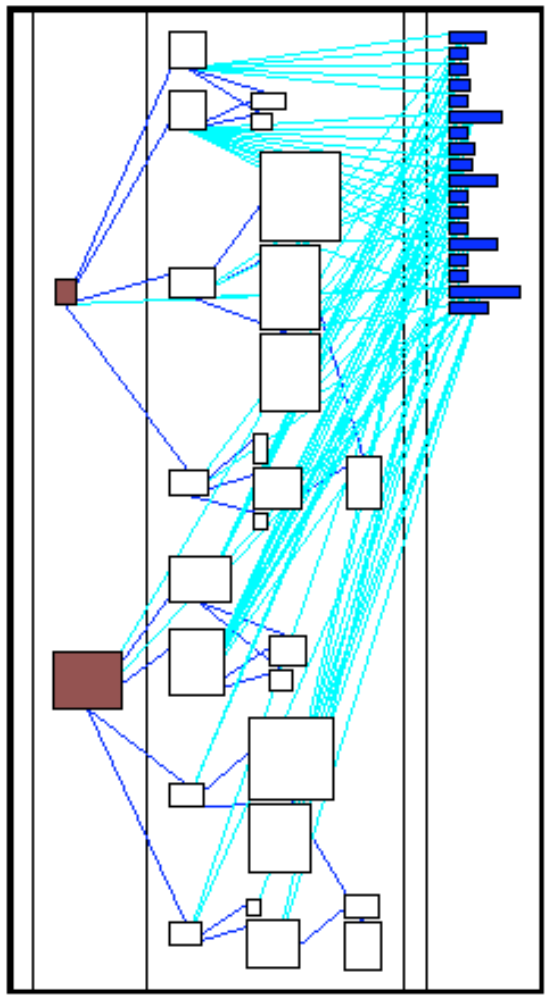
Lanza, Ducasse, 2005



Class Blueprint reveals patterns.



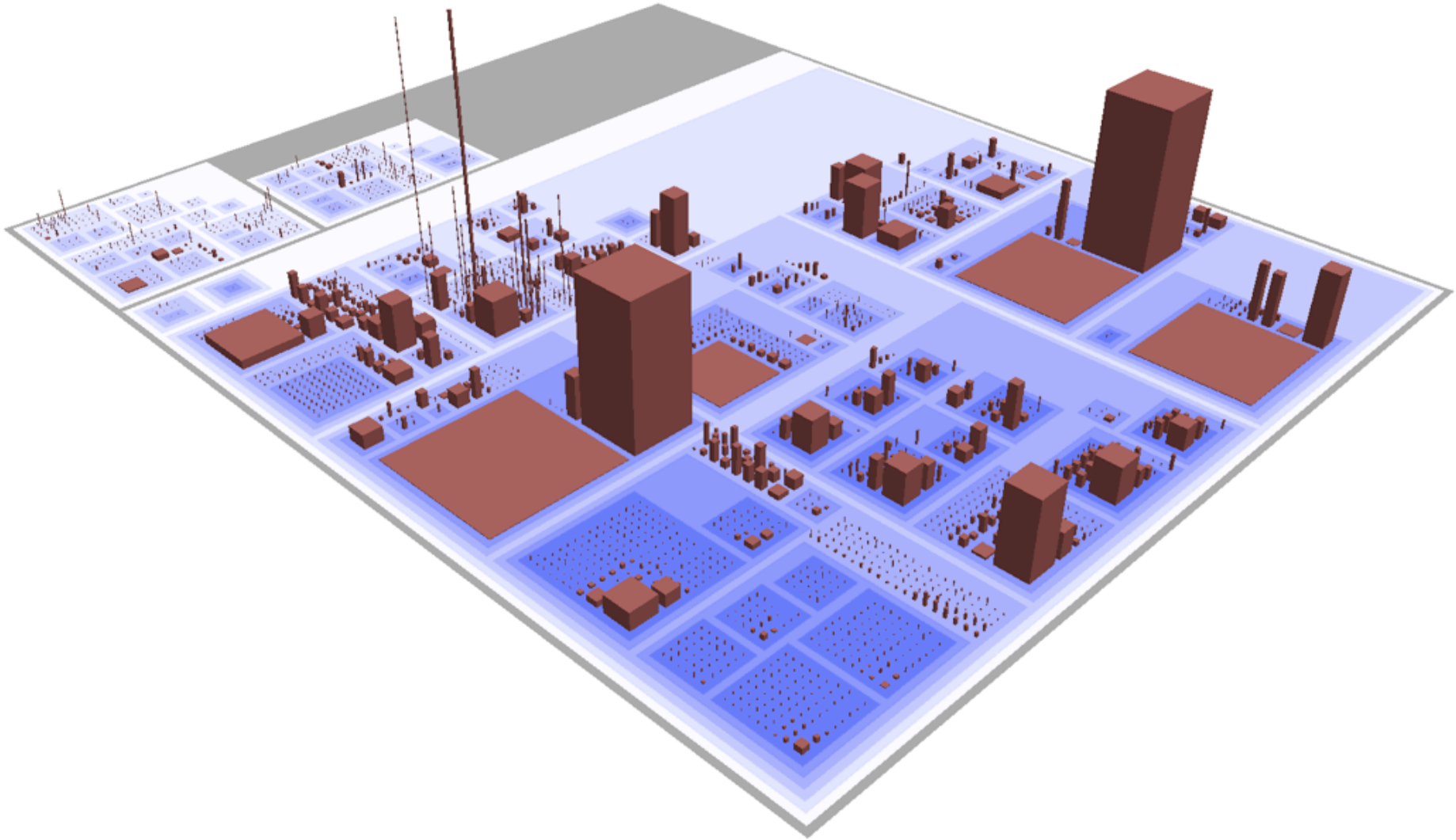
twin classes



schizophrenic class

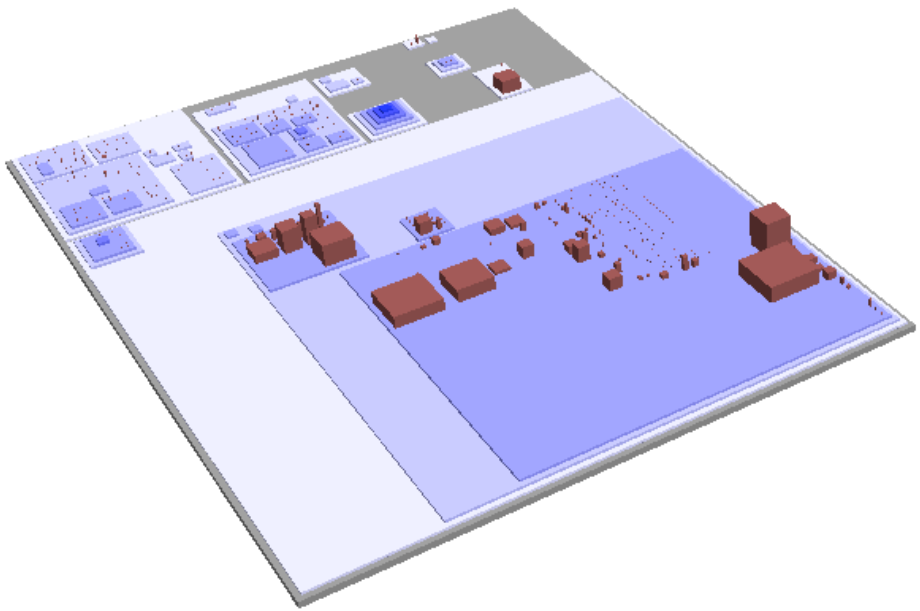
Code City shows where your code lives.

Wettel, Lanza, 2007

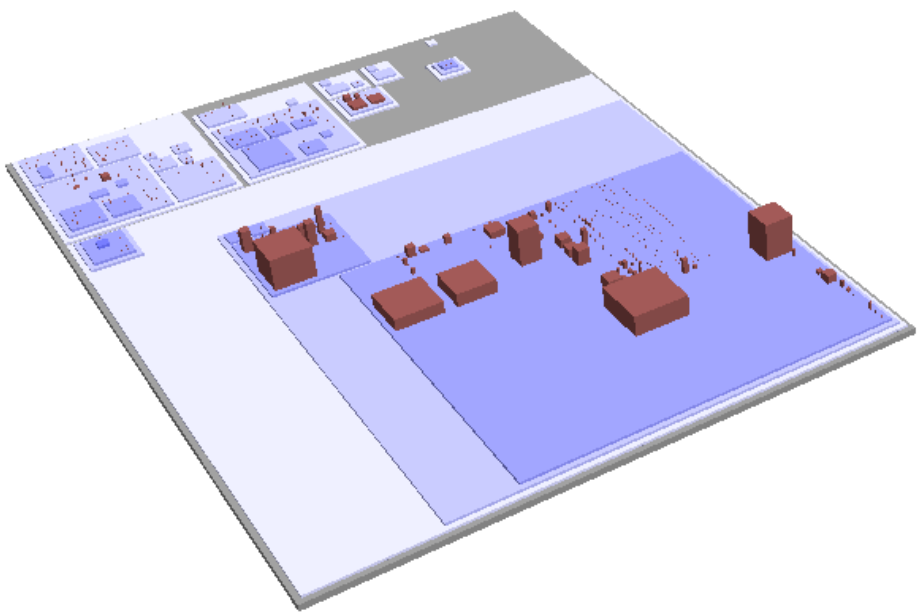


classes are buildings grouped in quarters of packages

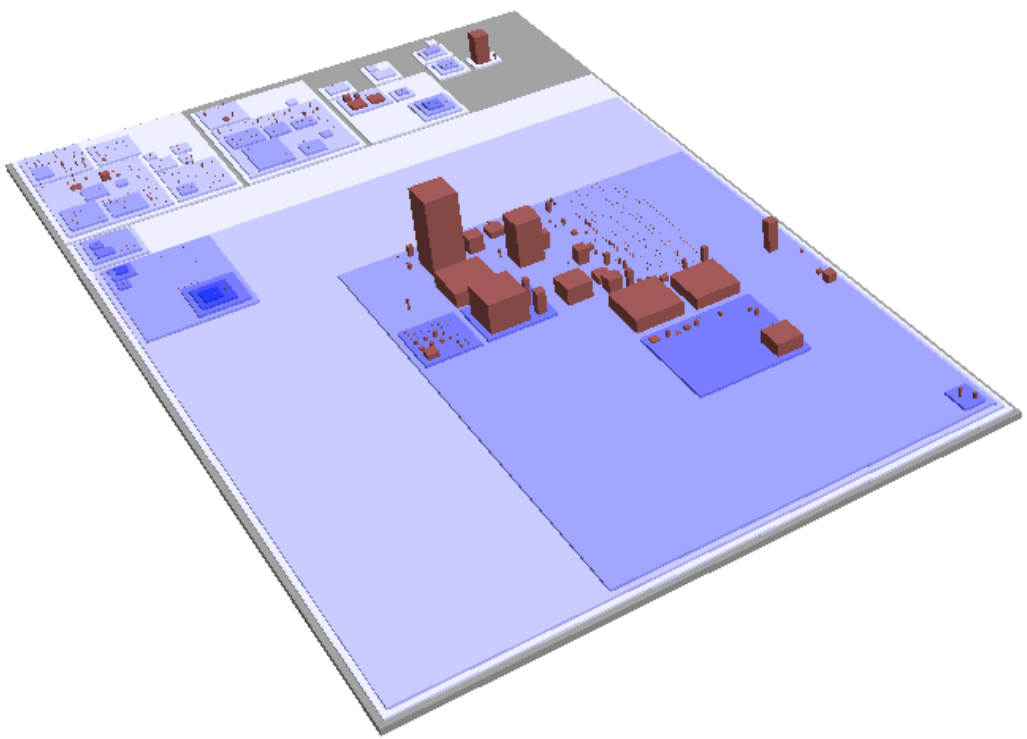
Jmol - The Time Machine



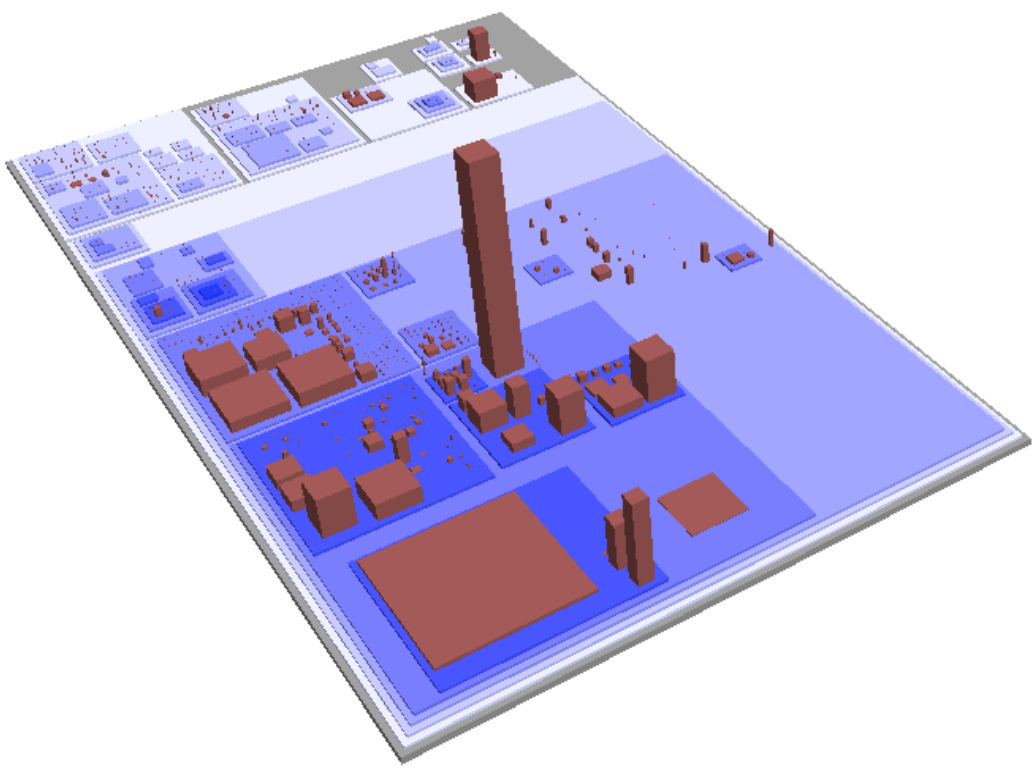
Jmol - The Time Machine



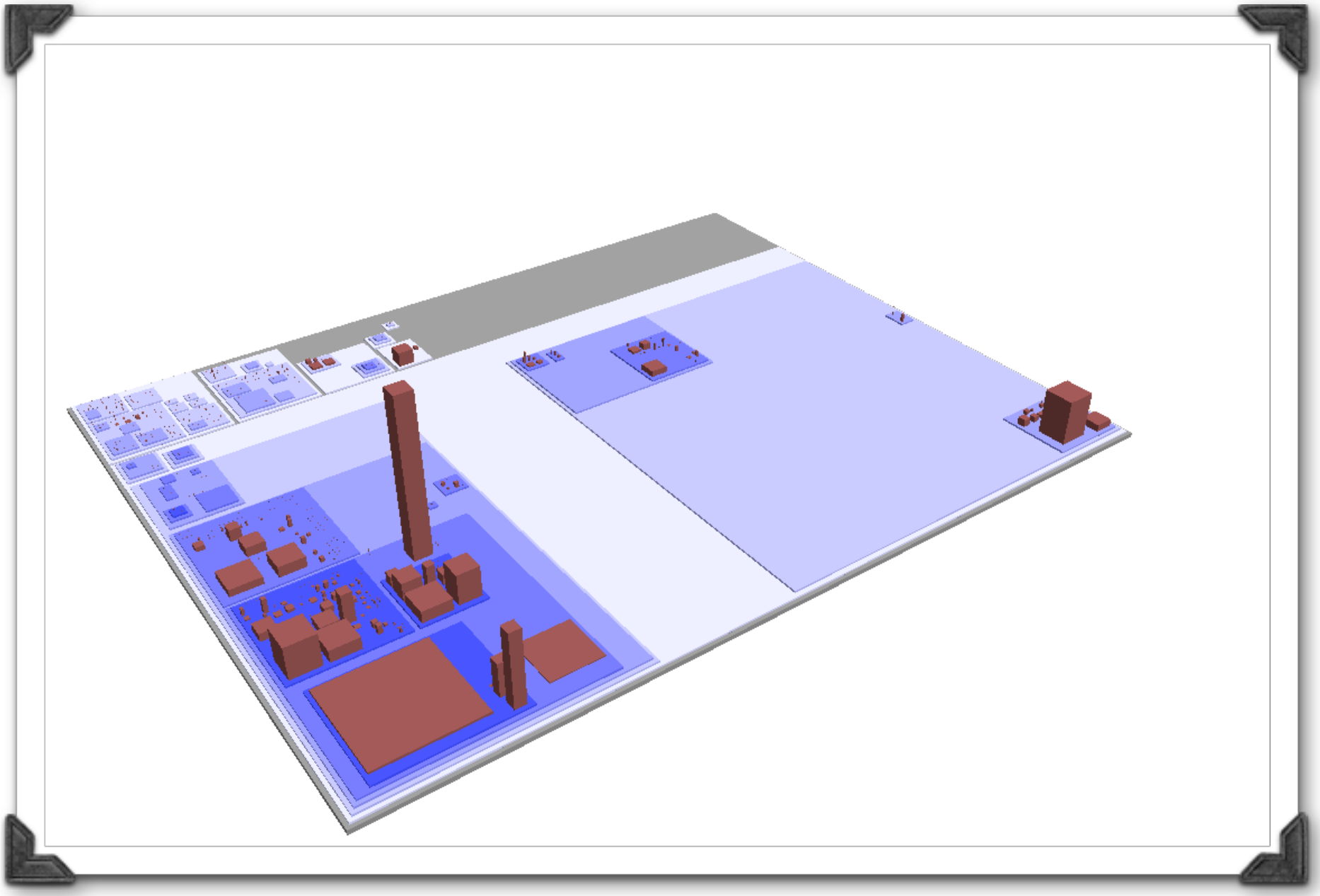
Jmol - The Time Machine



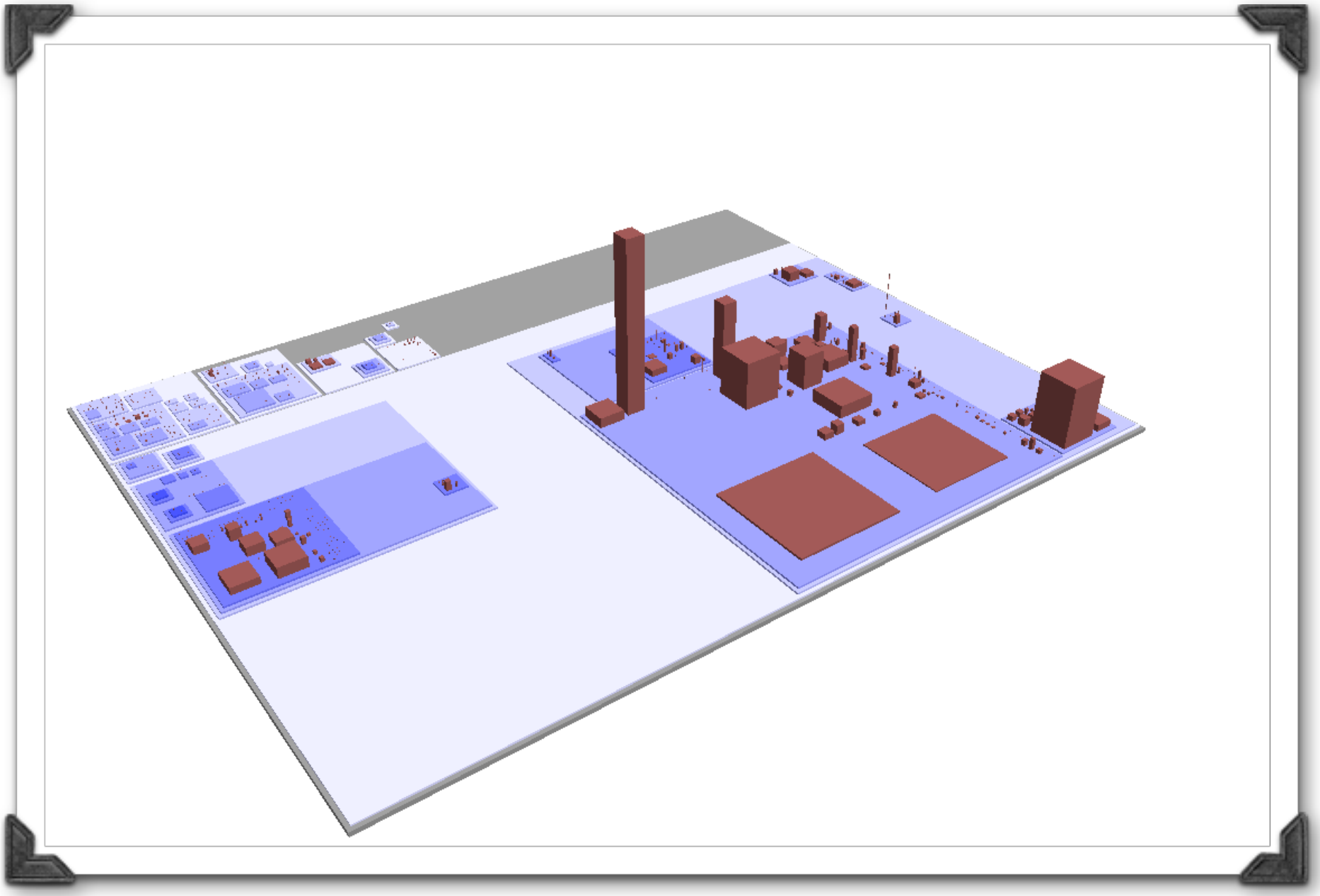
Jmol - The Time Machine



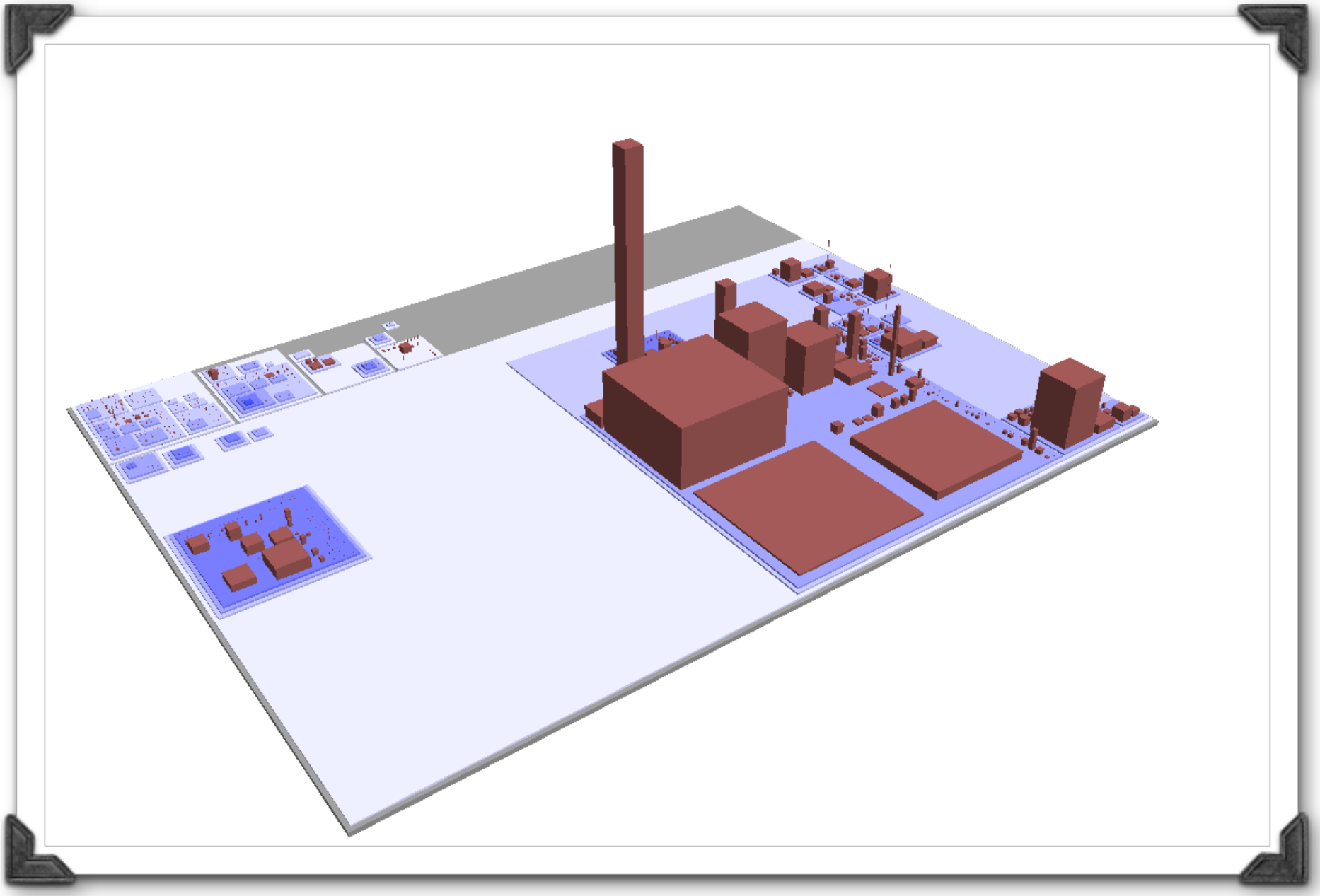
Jmol - The Time Machine



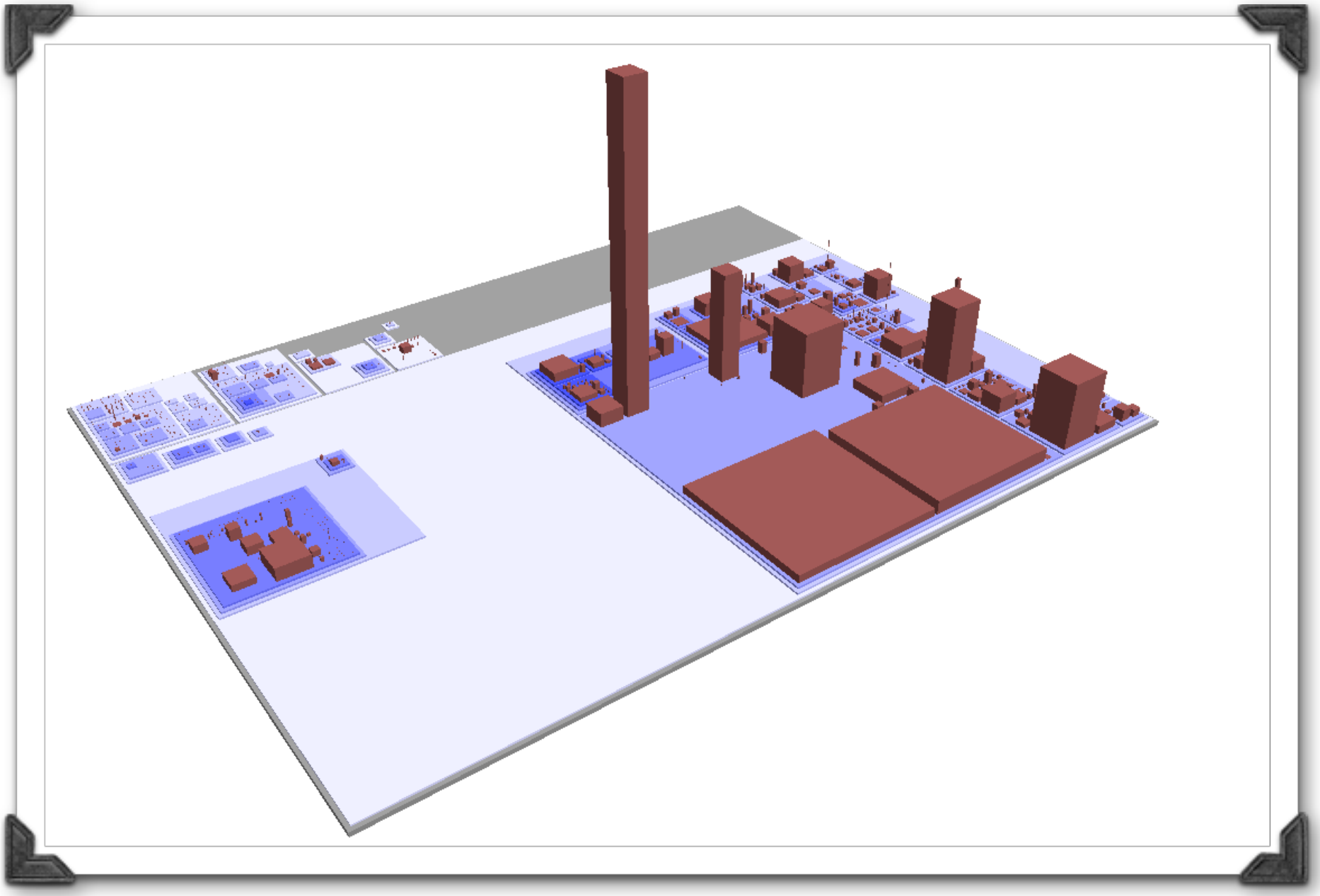
Jmol - The Time Machine

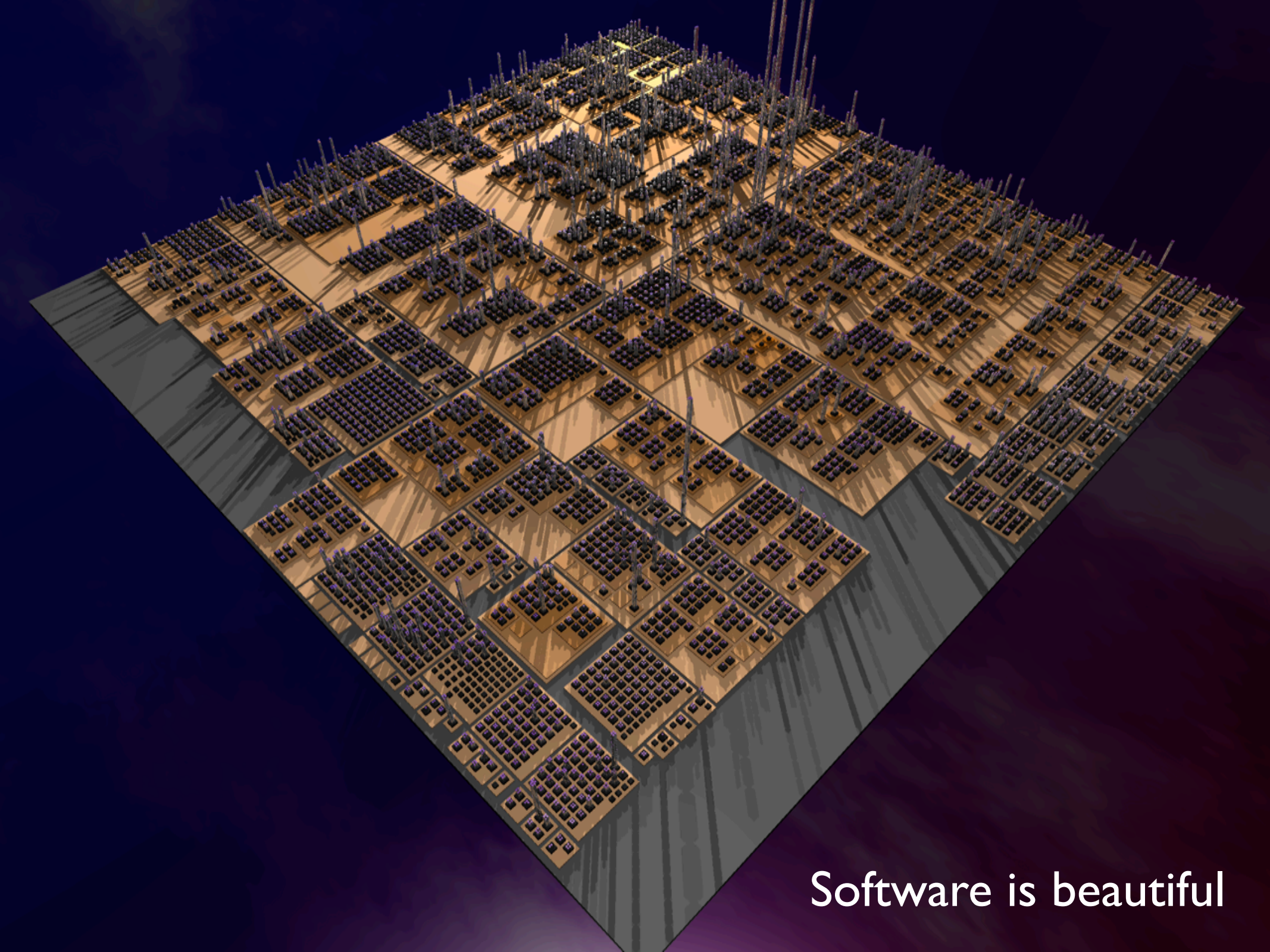


Jmol - The Time Machine



Jmol - The Time Machine




Software is beautiful

Tudor Gîrba, Michele Lanza, Radu Marinescu