Software Reenineering
P1: Reverse Engineering

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Outline

What is and Why?

Initial understanding

Detailed model capture

DA4Java demo

What is Reverse Engineering and why?

Reverse Engineering is the process of analyzing a subject system

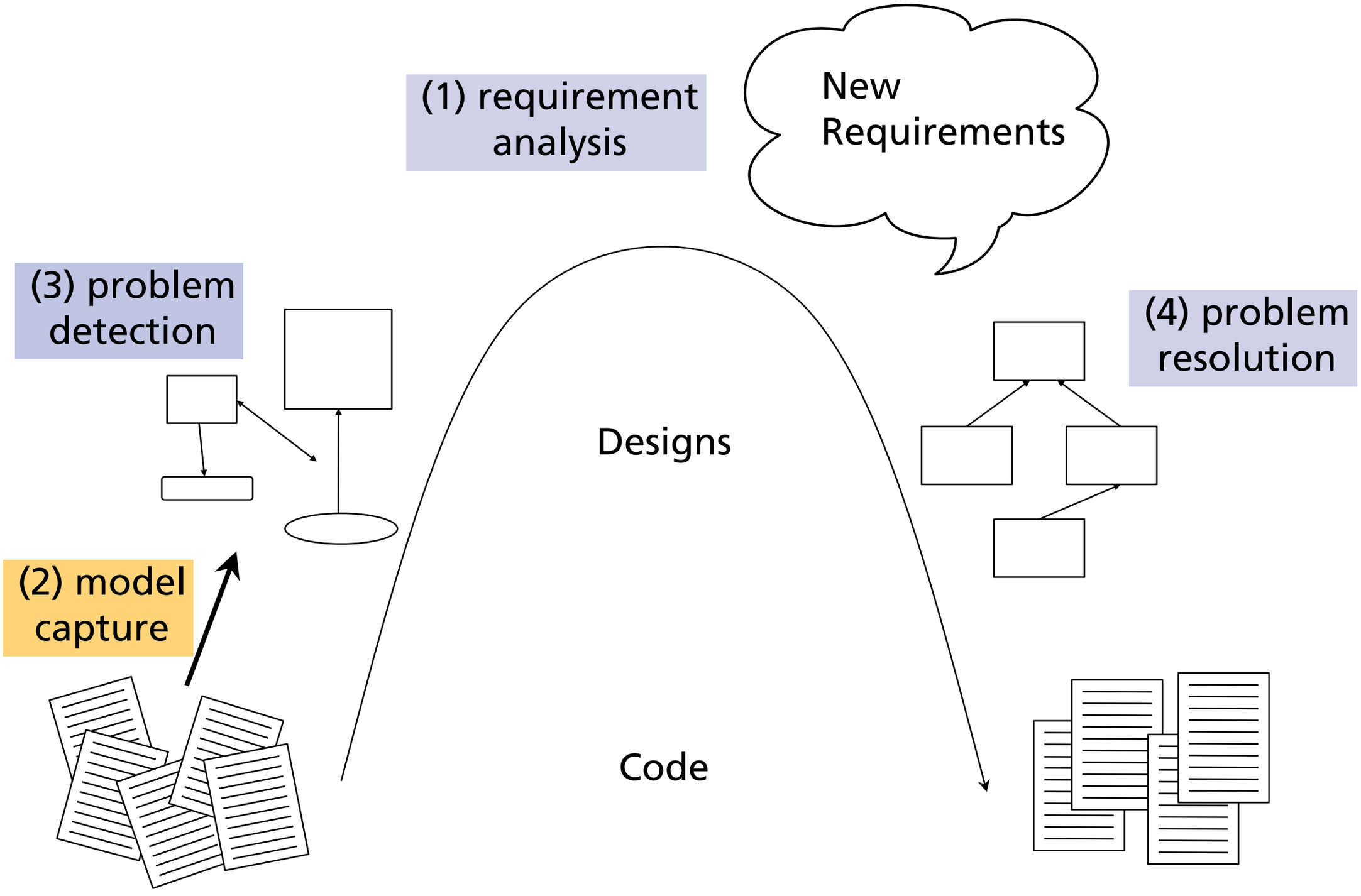
to identify the system's components and their interrelationships and

create representations of the system in another form or at a higher level of abstraction [Chikofsky & Cross, '90]

Motivation

Understanding other people's code, the design and architecture in order to maintain and evolve them

Reengineering Life-Cycle



Initial understanding

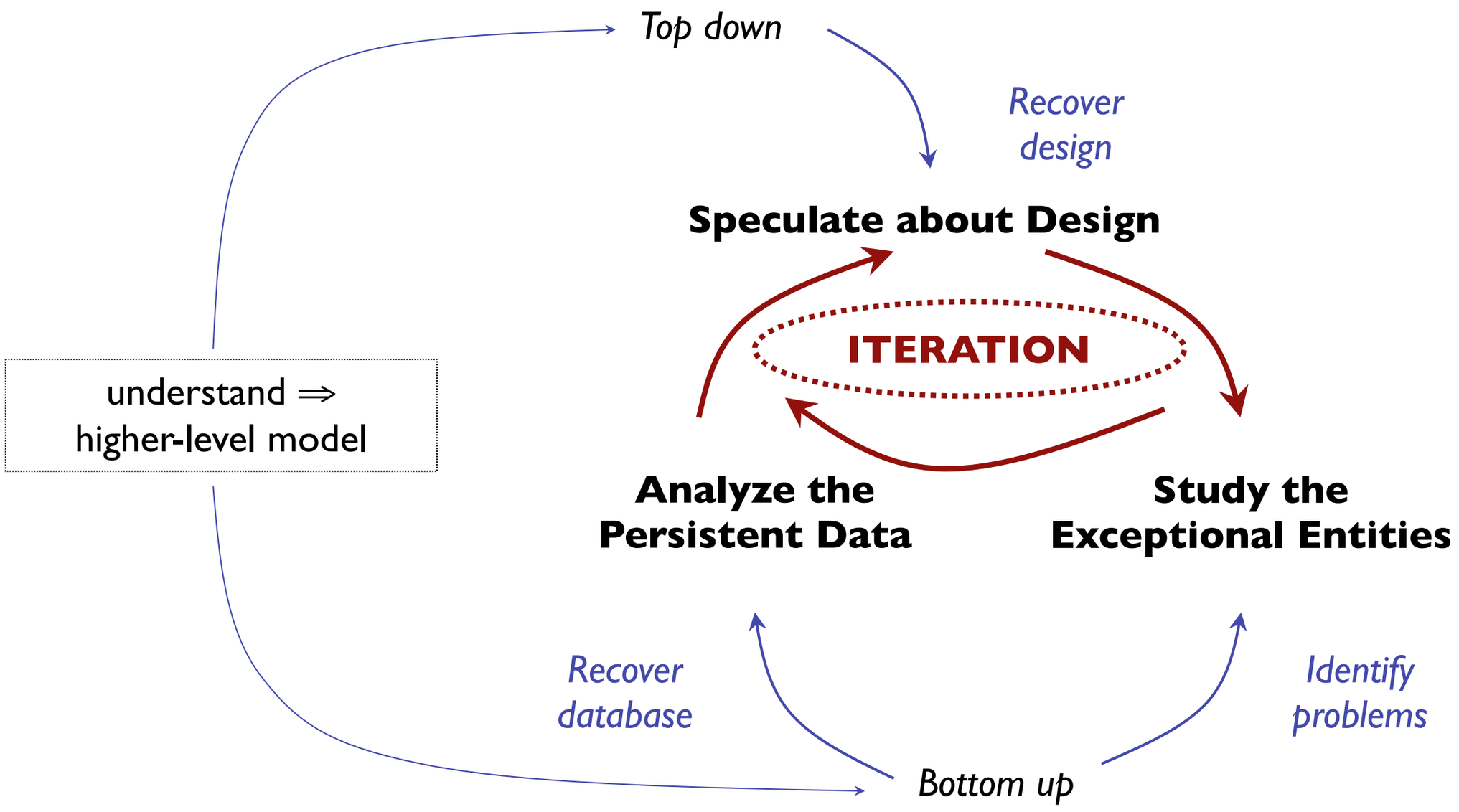
Initial understanding patterns

Goal: Get initial understanding of the design and implementation of the system

Forces

- Data is deceptive
  - Always double-check your sources
- Understanding entails iteration
  - Plan iteration and feedback loops
- Knowledge must be shared
  - “Put the map on the wall”
- Teams need to communicate
  - “Use their language”

Initial understanding patterns



Analyze the persistent data

Problem: Which objects represent valuable data?

Solution: Analyze the database schema

Prepare Model

Table ⇒ class

Columns ⇒ class attributes

Candidate keys

- Naming conventions + unique indices

Foreign keys ⇒ class associations

- Use explicit foreign key declarations
- Infer from column types + naming conventions + view declarations + join clauses

Analyze the persistent data (cont.)

Incorporate Inheritance

- One to one; rolled down; rolled up

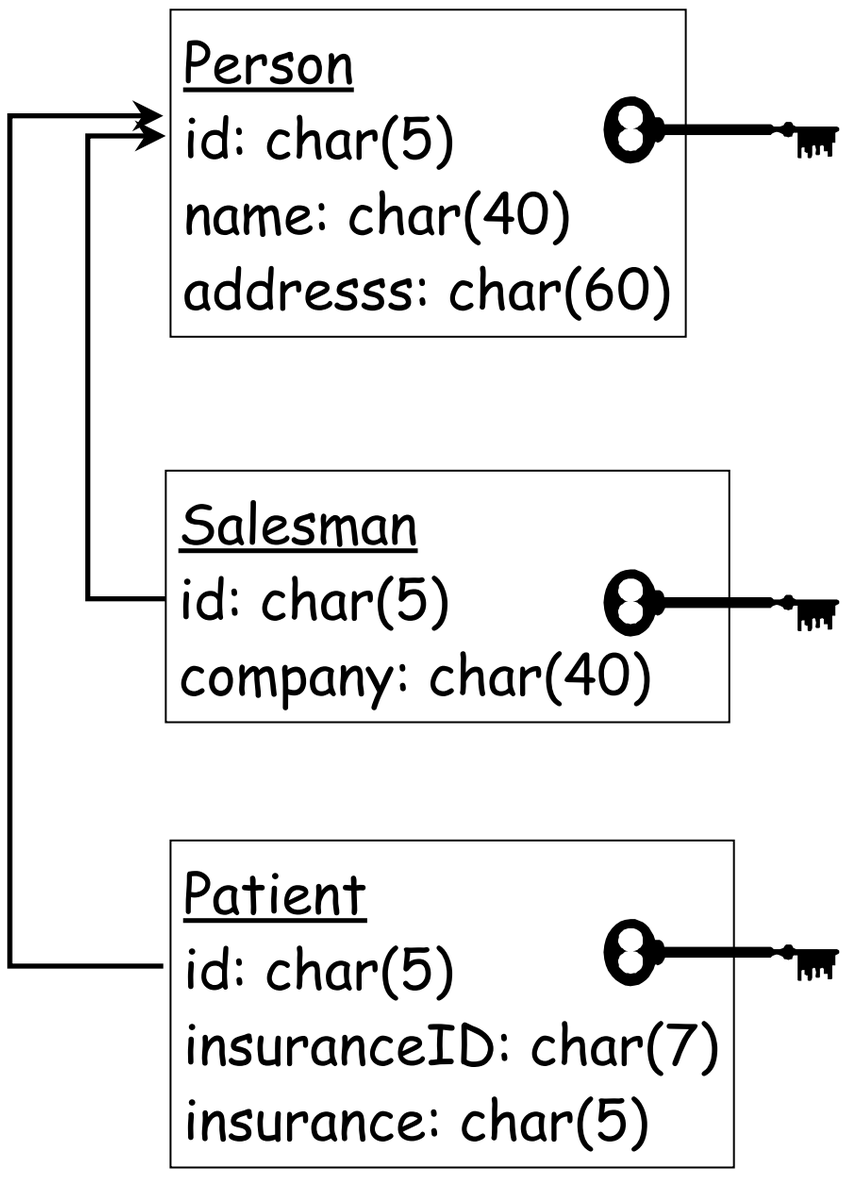
Incorporate Associations

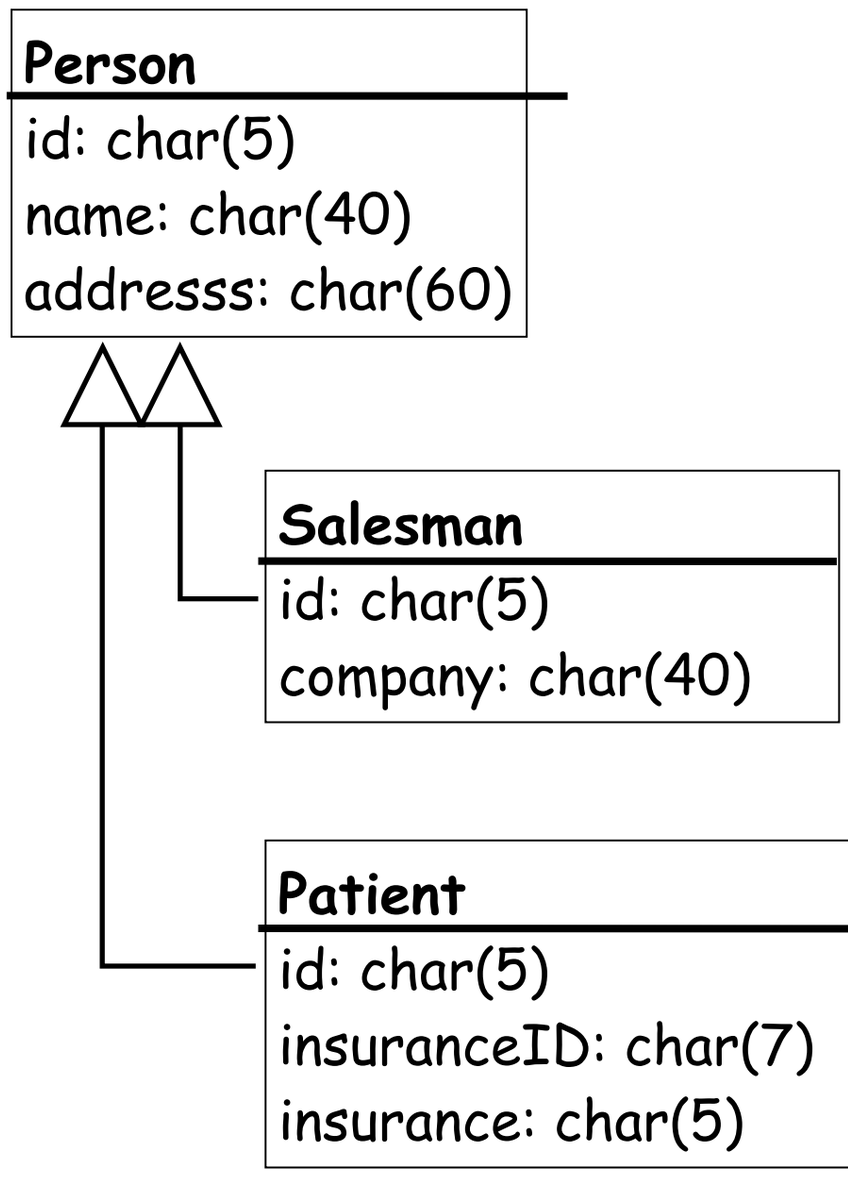
- Determine association classes (e.g., many-to-many associations)
- Merge complementary associations
- Identify qualified associations

Verification

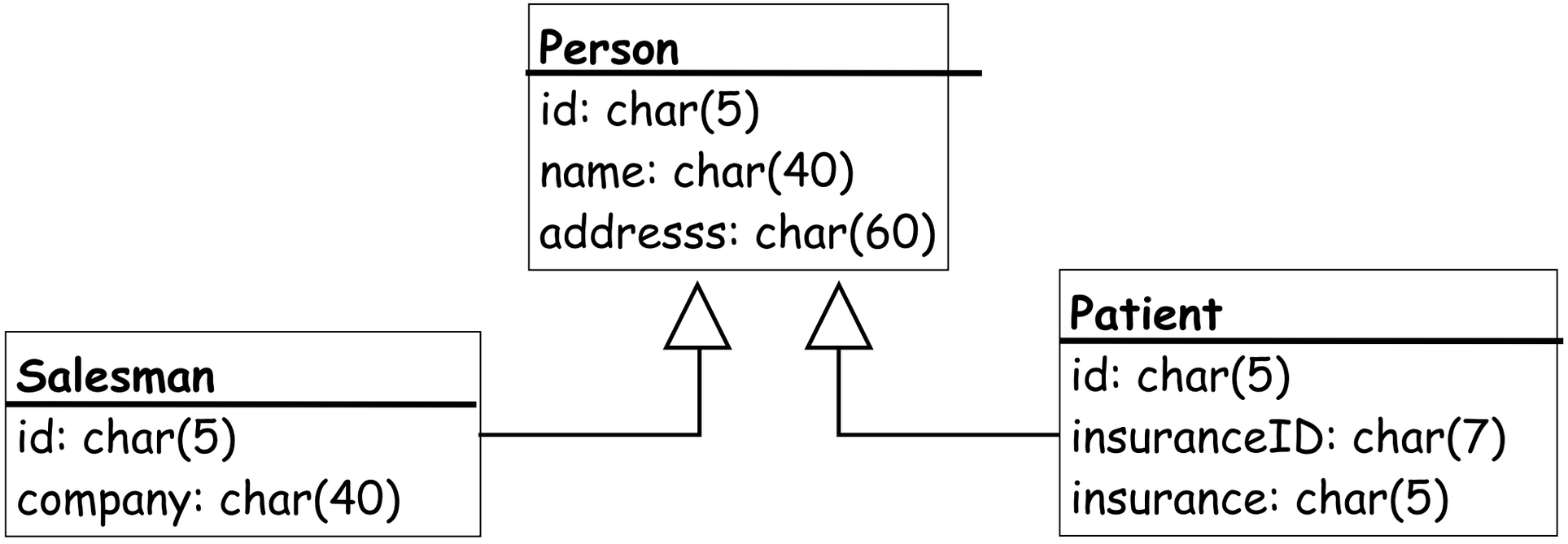
- Data samples + SQL statements

Example: One To One





Example: Rolled Down



Speculate about design

Problem: How do you recover the design from source code?

Solution: Develop hypotheses and check them

- Develop a plausible class diagram and iteratively check and refine your design against the actual code

Variants

- Speculate about Business Objects
- Speculate about Design Patterns
- Speculate about Architecture

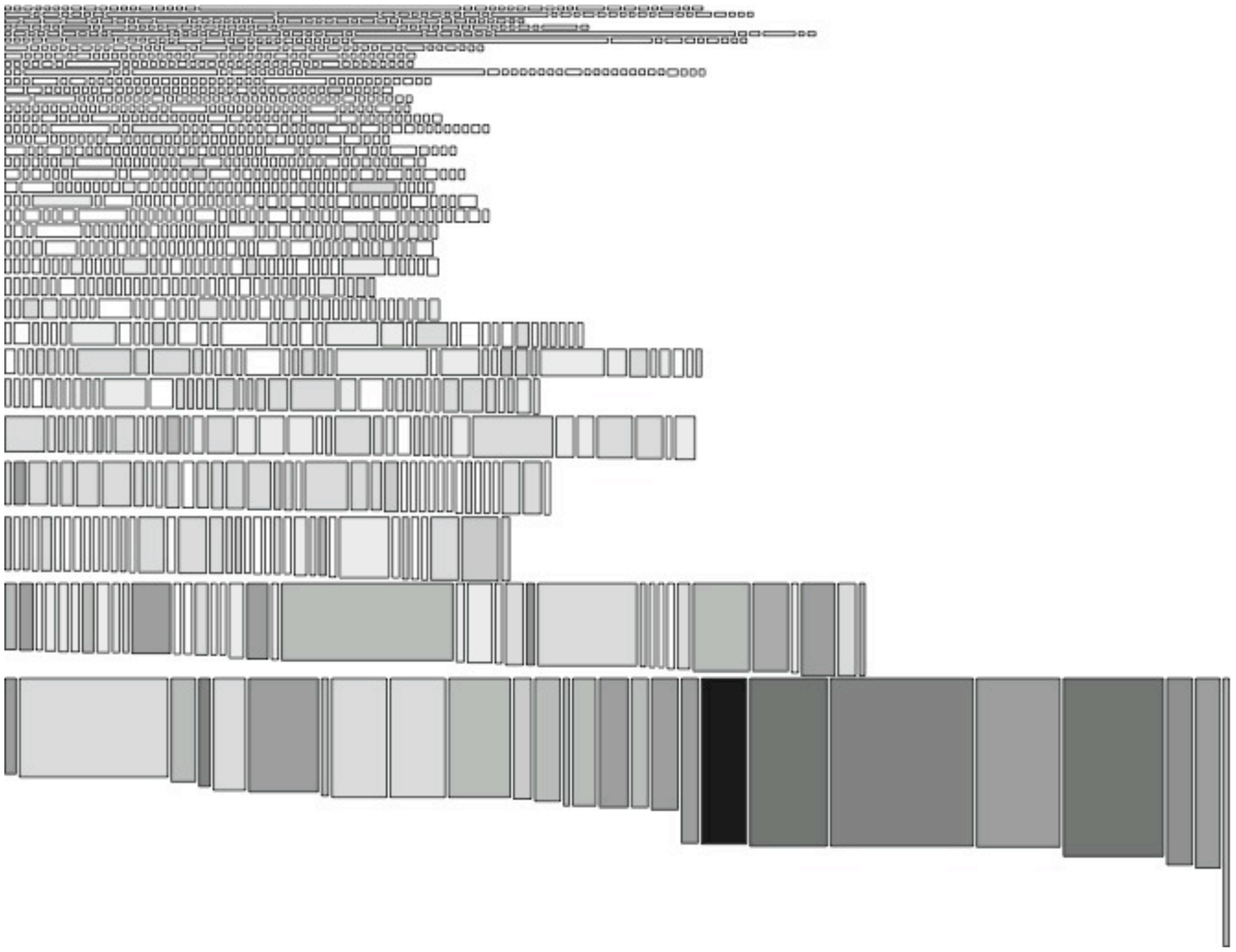
Study the exceptional entities

Problem: How can you quickly identify design problems?

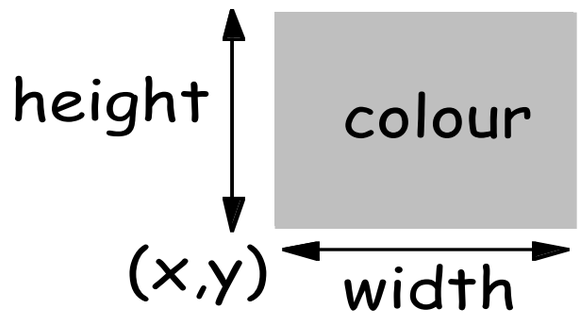
Solution: Measure software entities and study the anomalous ones

- Visualize metrics to get an overview
- Use simple metrics
  - Lines of code
  - Number of methods
  - ...

Example: Exceptional entities



Use simple metrics and layout algorithms



Detailed model capture

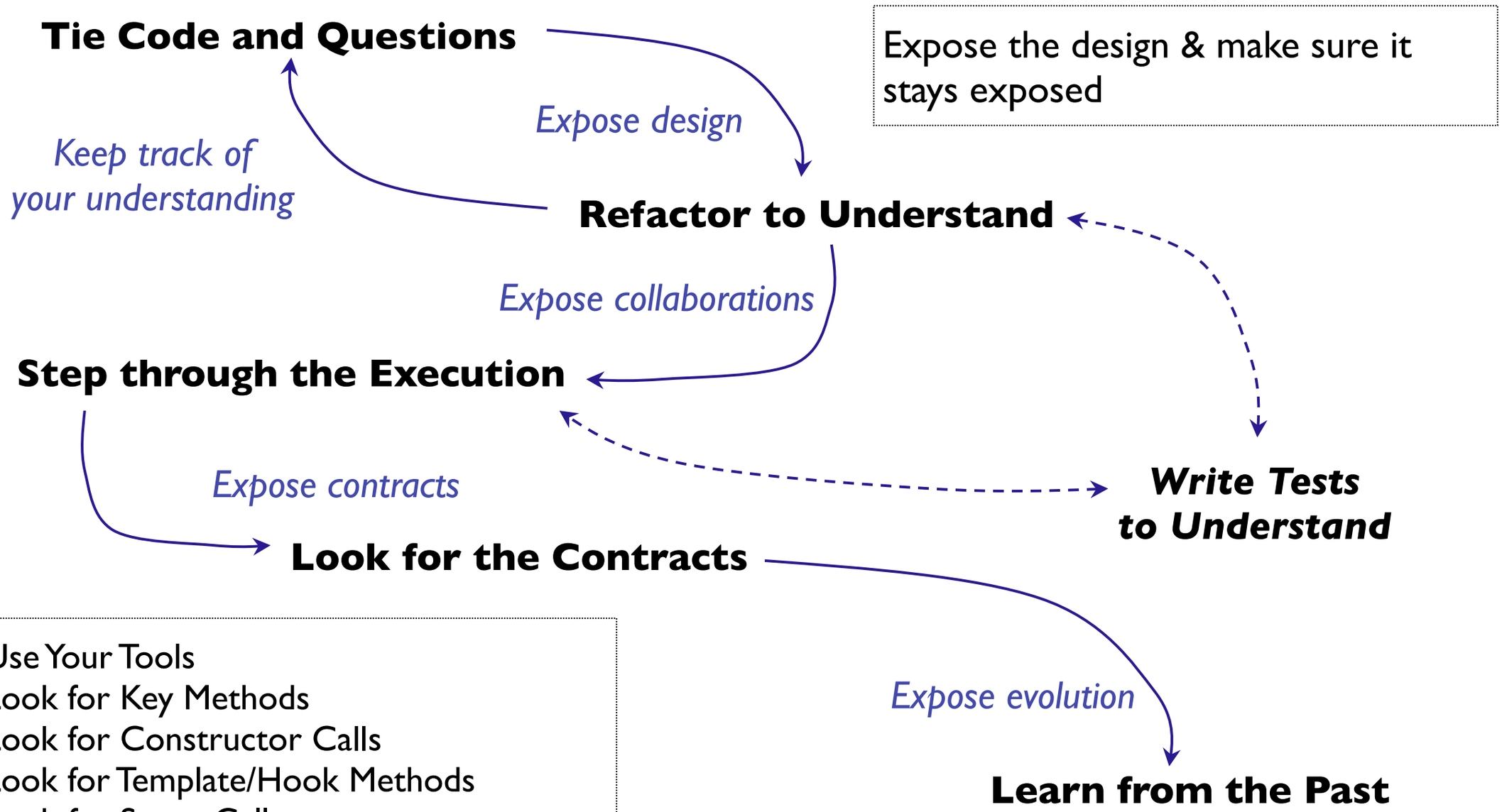
Detailed model capture patterns

Goal: Build a detailed model of parts that will be important for reengineering

Forces

- Details matter
  - Pay attention to the details
- Design remains implicit
  - Record design rationale when you discover it
- Design evolves
  - Important issues are reflected in changes to the code
- Code only exposes static structure
  - Study dynamic behaviour to extract detailed design

Detailed model capture patterns



- Use Your Tools
- Look for Key Methods
- Look for Constructor Calls
- Look for Template/Hook Methods
- Look for Super Calls

Tie code and questions

Problem: How do you keep track of your understanding?

Solution: Annotate the code

- List questions, hypotheses, tasks and observations
- Identify yourself
- Use conventions to locate/extract annotations
  - E.g., ‘To: Jasmine By: Martin On: 10.10.05 Comment...’
- Annotate as comments or as methods

Refactor to understand

Problem: How do you decipher cryptic code?

Solution: Refactor it till it makes sense

- Goal (for now) is to understand, not to reengineer

Hints

- Work with a copy of the code
- Refactoring requires an adequate test base
  - If this is missing, “Write Tests to Understand”

Refactor to understand (cont.)

Guidelines

- Rename attributes to convey roles
- Rename methods and classes to reveal intent
- Remove duplicated code
- Replace condition branches by methods

Step through the execution

Problem: How do you uncover the run-time architecture?

- Collaborations are spread throughout the code
- Polymorphism may hide which classes are instantiated

Solution: Execute scenarios of known use cases and step through the code with a debugger

Hints

- Set breakpoints
- Change internal state to test alternative paths

Look for the contracts

Problem: What does a class expect from its clients?

- Interfaces are visible in the code but how to use them?

Solution: Look for common programming idioms

- Look for “key methods”
  - Method name, parameter types (important type -> important method)
- Constructor calls
  - Shows which parameters to pass
- Template/hook methods
  - Shows how to specialize a sub-class

Example: yFiles Contract

Initializing a Swing component with a yFiles graph

```
public SNACockpit(DataProvider dataProvider, boolean animated) {
    super(new BorderLayout());

    this.fGraphModel = new SocialNetworkGraph(dataProvider);
    view = new Graph2DView();
    view.setAntialiasedPainting(true);
    ((DefaultGraph2DRenderer) view.getGraph2DRenderer()).setDrawEdgesFirst(true);

   ...

    view.setGraph2D(fGraphModel);
    this.add(view, BorderLayout.CENTER);
}
```

Learn from the past

Problem: How did the system get the way it is? Which parts are stable and which aren't?

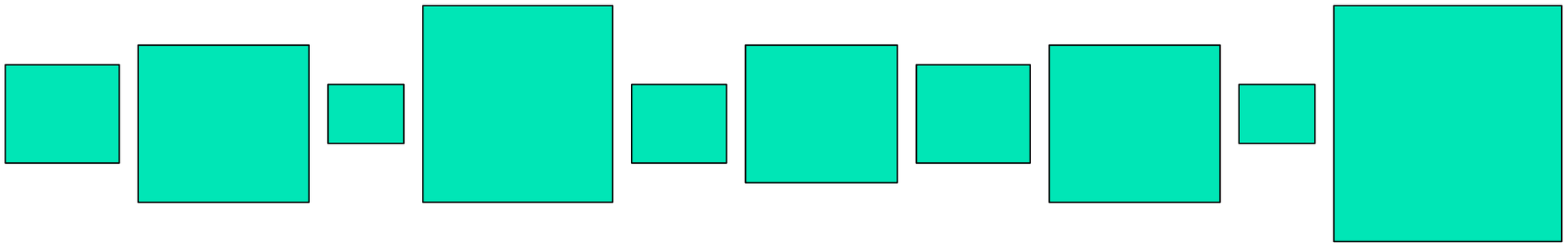
Solution: Compare versions to discover where code was removed

- Removed functionality is a sign of design evolution
- Use or develop appropriate tools

Look for signs of:

- Unstable design — repeated growth and refactoring
- Mature design — growth, refactoring, and stability

Examples: Unstable design



Pulsar: Repeated Modifications make it grow and shrink.
System Hotspot: Every System Version requires changes.

Summary

Initial Understanding + Detailed Model Capture

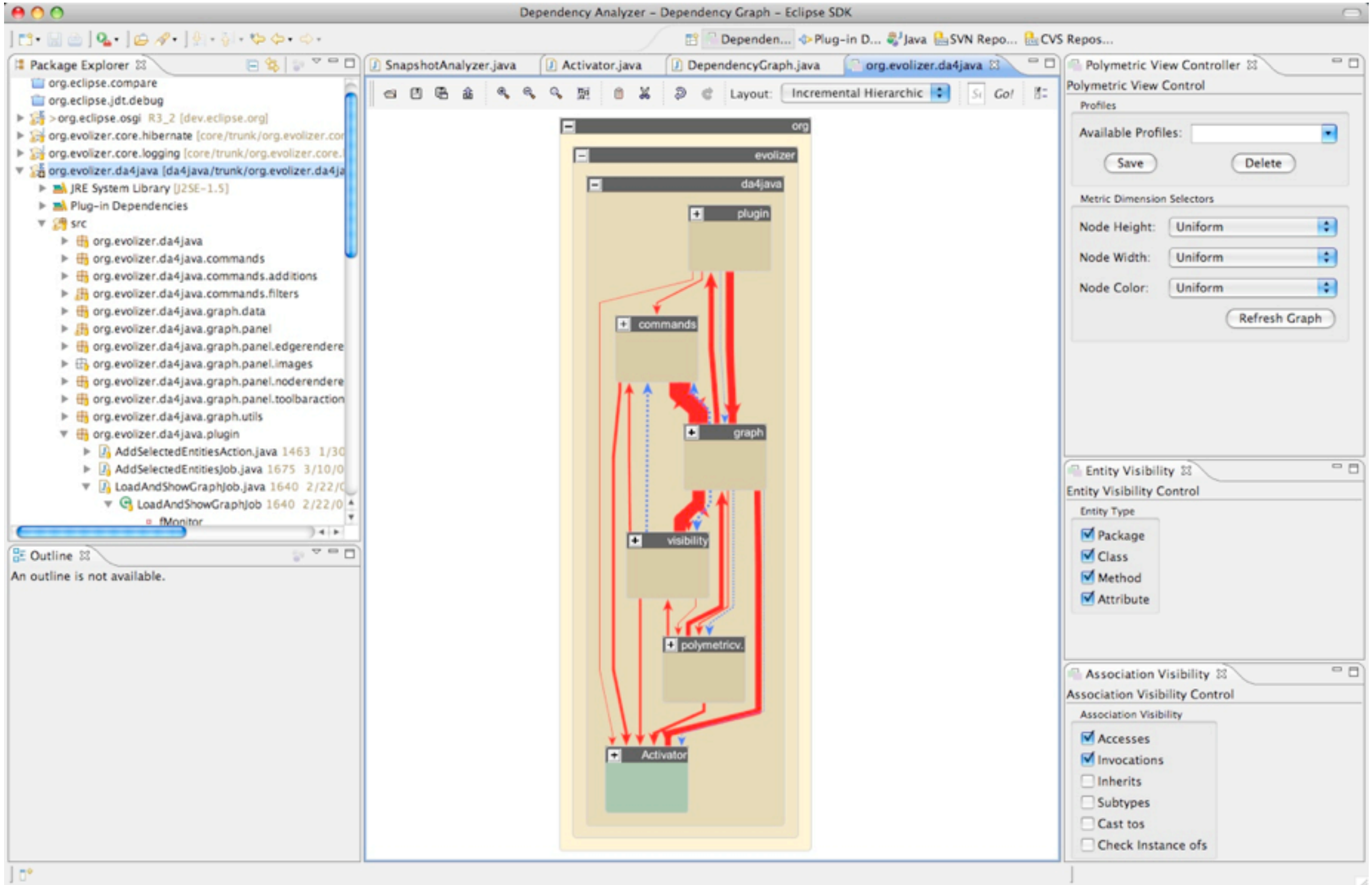
- Plan the work … and work the plan
- Frequent and short iterations

Issues

- Scale, speed vs. accuracy, politics
- Tools?

Reverse Engineering Tools

DA4Java


Dependency Analyzer – Dependency Graph – Eclipse SDK
Package Explorer
org.eclipse.compare
org.eclipse.jdt.debug
org.eclipse.osgi R3_2 [dev.eclipse.org]
org.evolizer.core.hibernate [core/trunk/org.evolizer.cor
org.evolizer.core.logging [core/trunk/org.evolizer.core.
org.evolizer.da4java [da4java/trunk/org.evolizer.da4ja
JRE System Library [J2SE-1.5]
Plug-in Dependencies
src
org.evolizer.da4java
org.evolizer.da4java.commands
org.evolizer.da4java.commands.additions
org.evolizer.da4java.commands.filters
org.evolizer.da4java.graph.data
org.evolizer.da4java.graph.panel
org.evolizer.da4java.graph.panel.edgerendere
org.evolizer.da4java.graph.panel.images
org.evolizer.da4java.graph.panel.noderendere
org.evolizer.da4java.graph.panel.toolbaraction
org.evolizer.da4java.graph.utils
org.evolizer.da4java.plugin
AddSelectedEntitiesAction.java 1463 1/30
AddSelectedEntitiesJob.java 1675 3/10/0
LoadAndShowGraphJob.java 1640 2/22/0
LoadAndShowGraphJob 1640 2/22/0
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SnapshotAnalyzer.java
Activator.java
DependencyGraph.java
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graph
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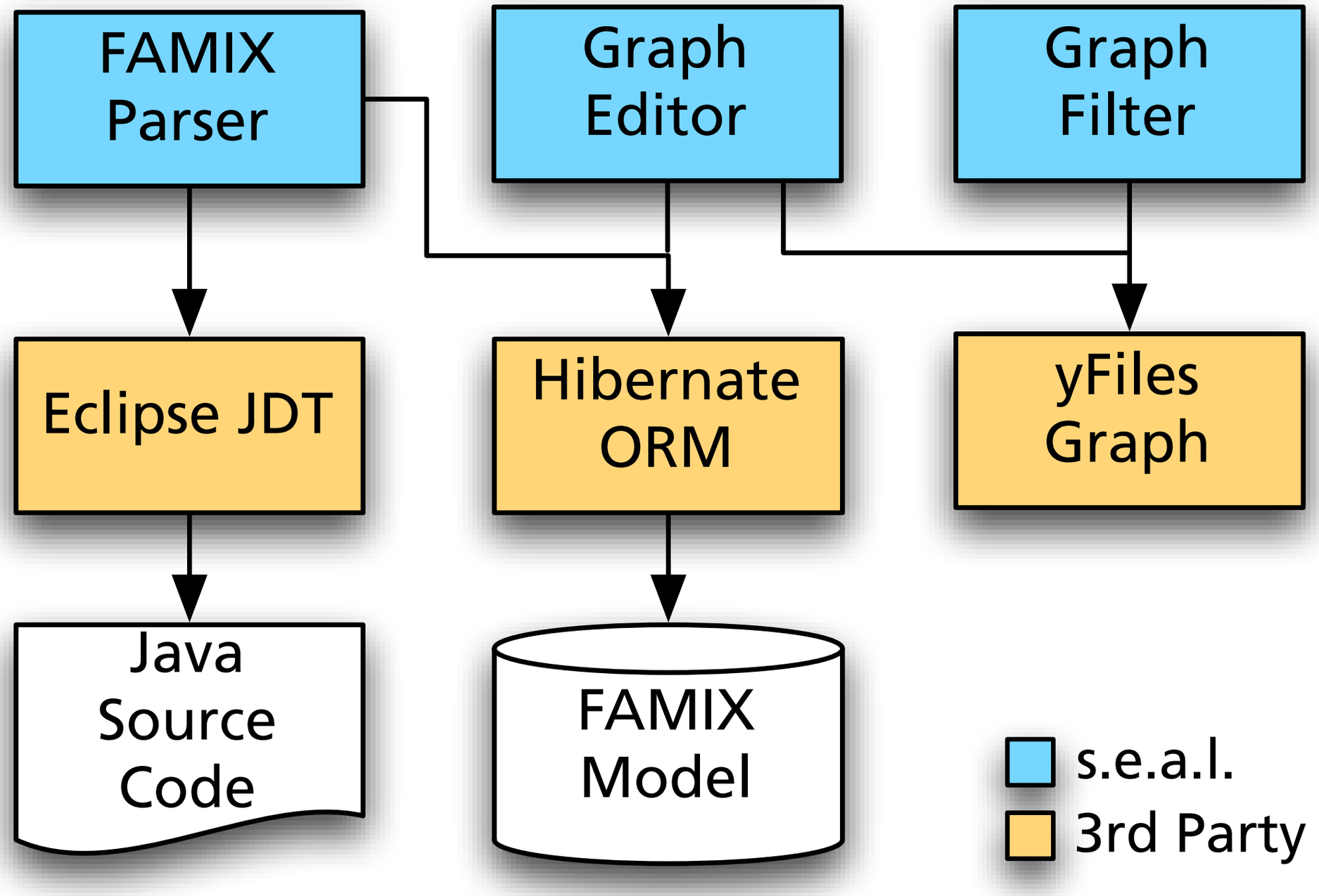
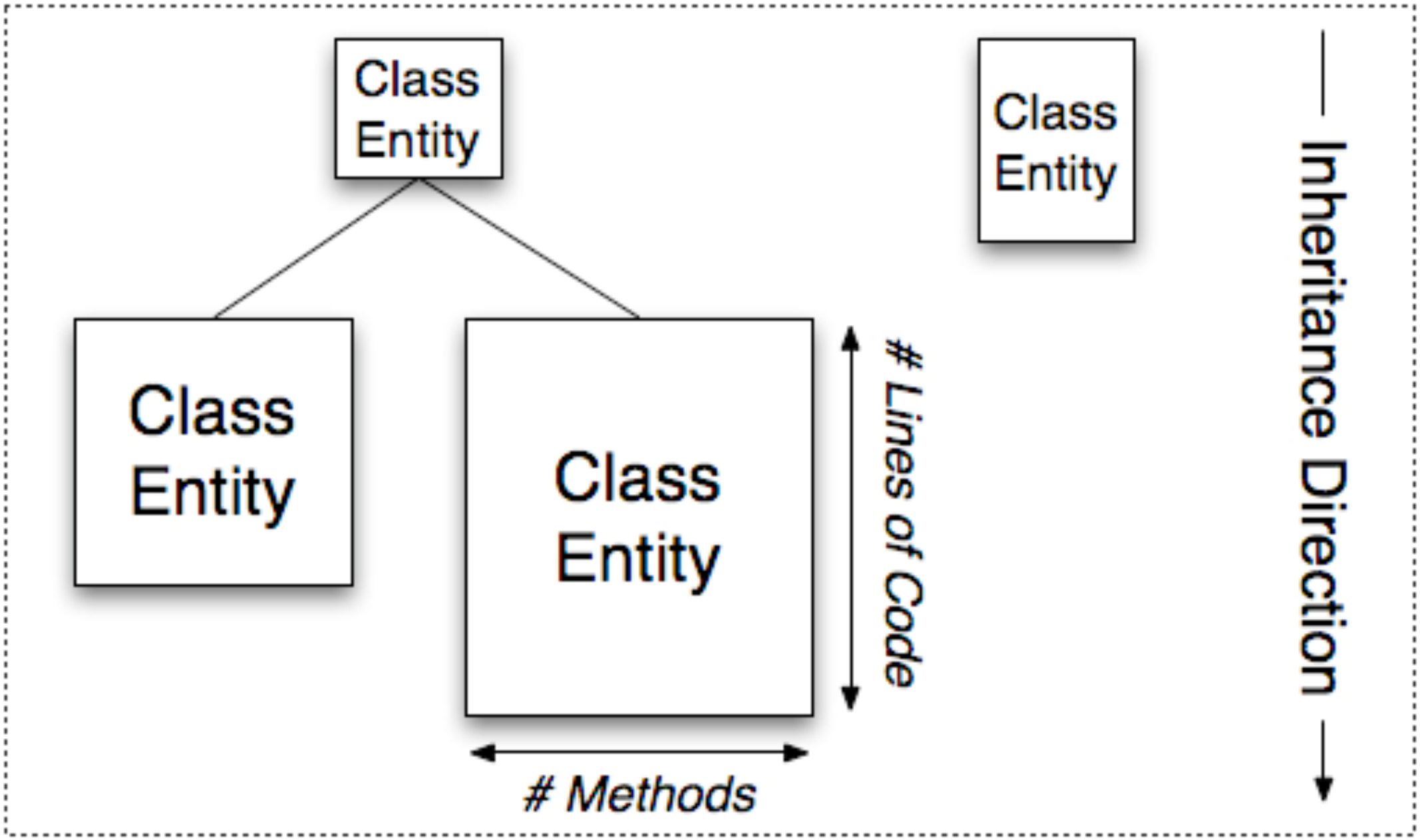
polymetricv.
Activator
Polymetric View Controller
Polymetric View Control
Profiles
Available Profiles:
Save
Delete
Metric Dimension Selectors
Node Height:
Uniform
Node Width:
Uniform
Node Color:
Uniform
Refresh Graph
Entity Visibility
Entity Visibility Control
Entity Type
Package
Class
Method
Attribute
Association Visibility
Association Visibility Control
Association Visibility
Accesses
Invocations
Inherits
Subtypes
Cast tos
Check Instance ofs

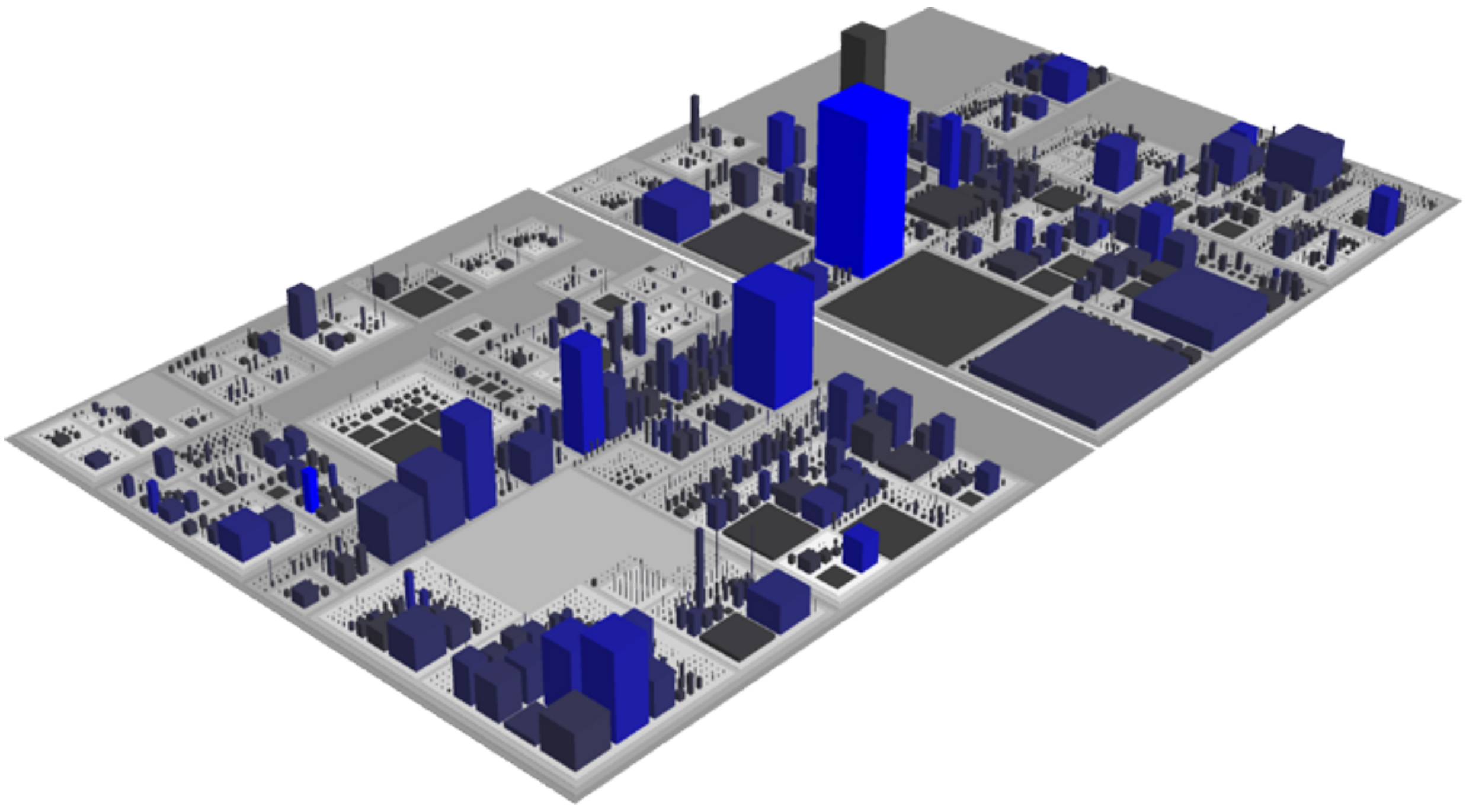
DA4Java Overview



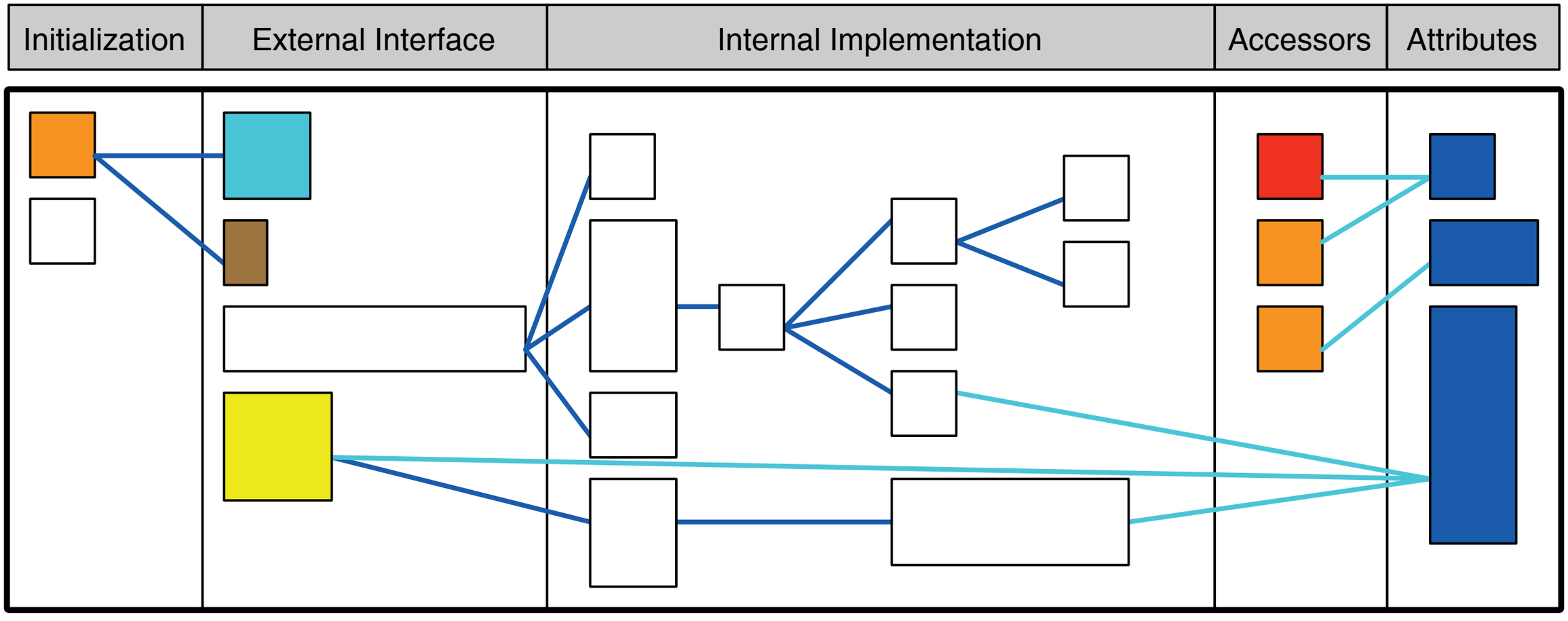
X-Ray

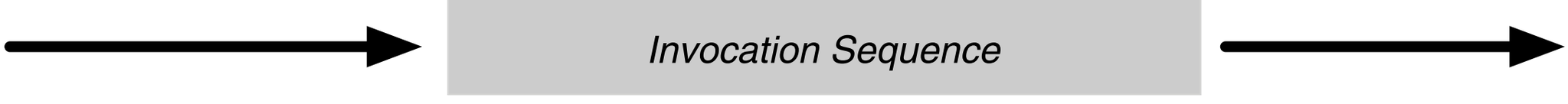

Class Entity
Class Entity
Class Entity
Class Entity
Lines of Code
Methods
Inheritance Direction

CodeCity

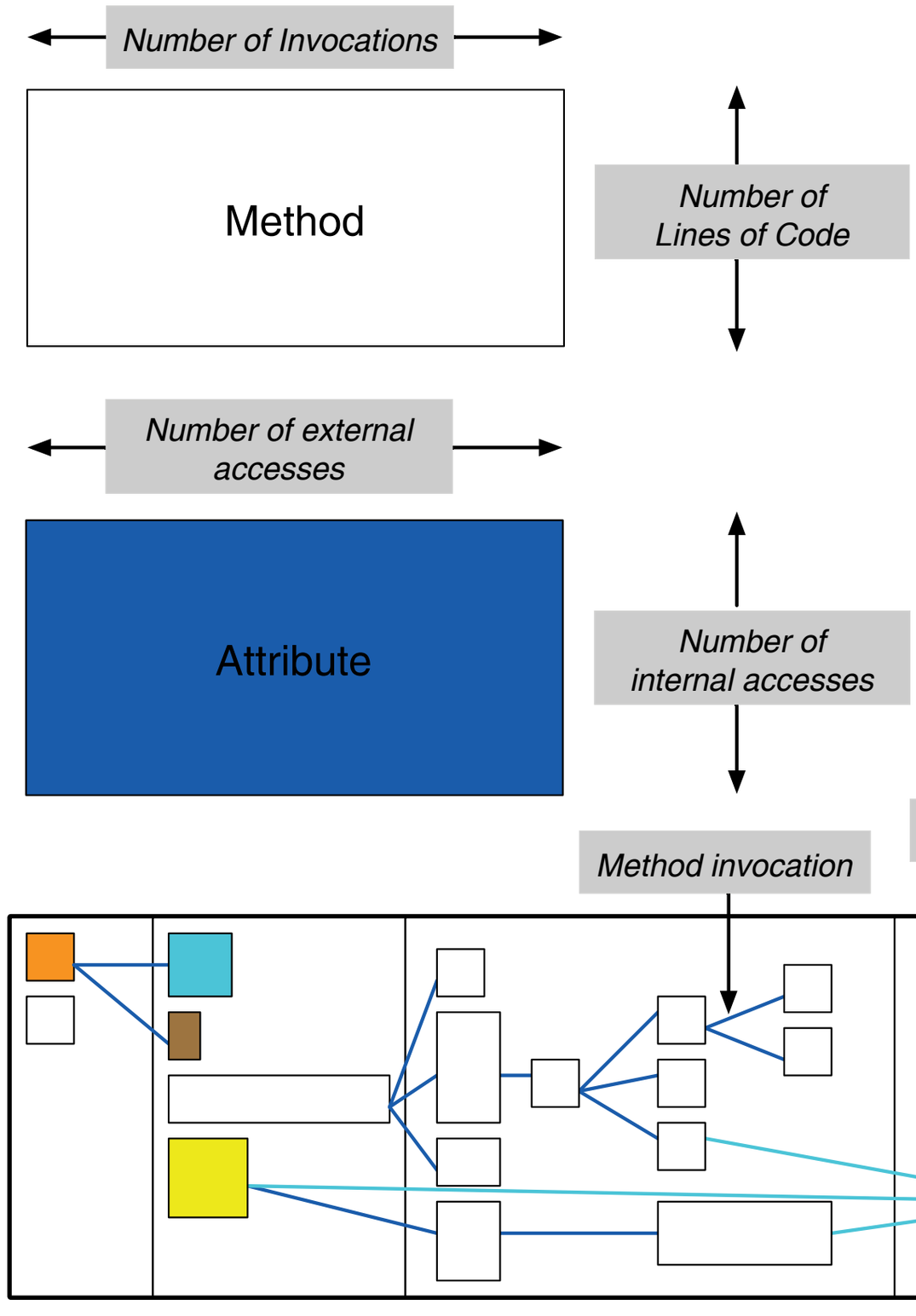


inCode - Class Blueprint





inCode - ClassBlueprint (cont.)



Abstract Method

Overriding Method

Delegating Method

Extending Method

Constant Method

Read Accessor Method

Write Accessor Method

Other visualization tools/prototypes

Structural Analysis for Java

http://www.alphaworks.ibm.com/tech/sa4j

inCode

http://loose.upt.ro/incode/pmwiki.php/

X-Ray

http://xray.inf.usi.ch/xray.php

Code City

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