Mendel:
A Model, Metrics, and Rules to Understand Class Hierarchies

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Outline

- Motivation and Problem
- Mendel Model
- Interesting Classes
- Subclassing Behaviors
- Conclusion

Motivation

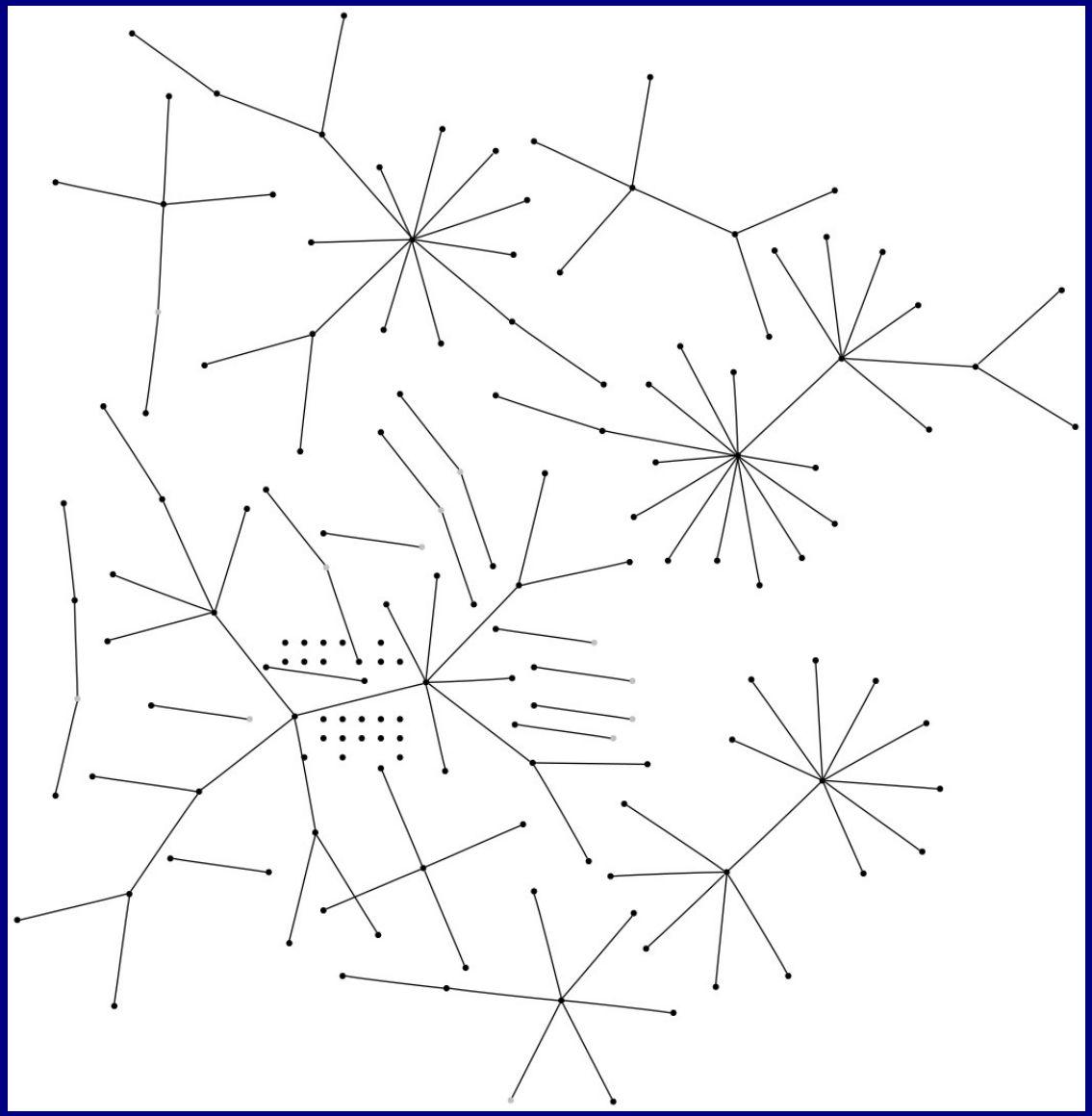
- Context: maintenance of program without documentation
  - Task: identify and understand the role of multiple classes
- Problem 1: where to start?
  - Find entry points (main(...))
  - Read large classes (by LOC or Number of Methods)
- Problem 2: what about inheritance?

Problem: Class Hierarchies

- Classes defined incrementally by inheritance
  - Class “interesting” in its own hierarchy
  - Class profiting from its hierarchy

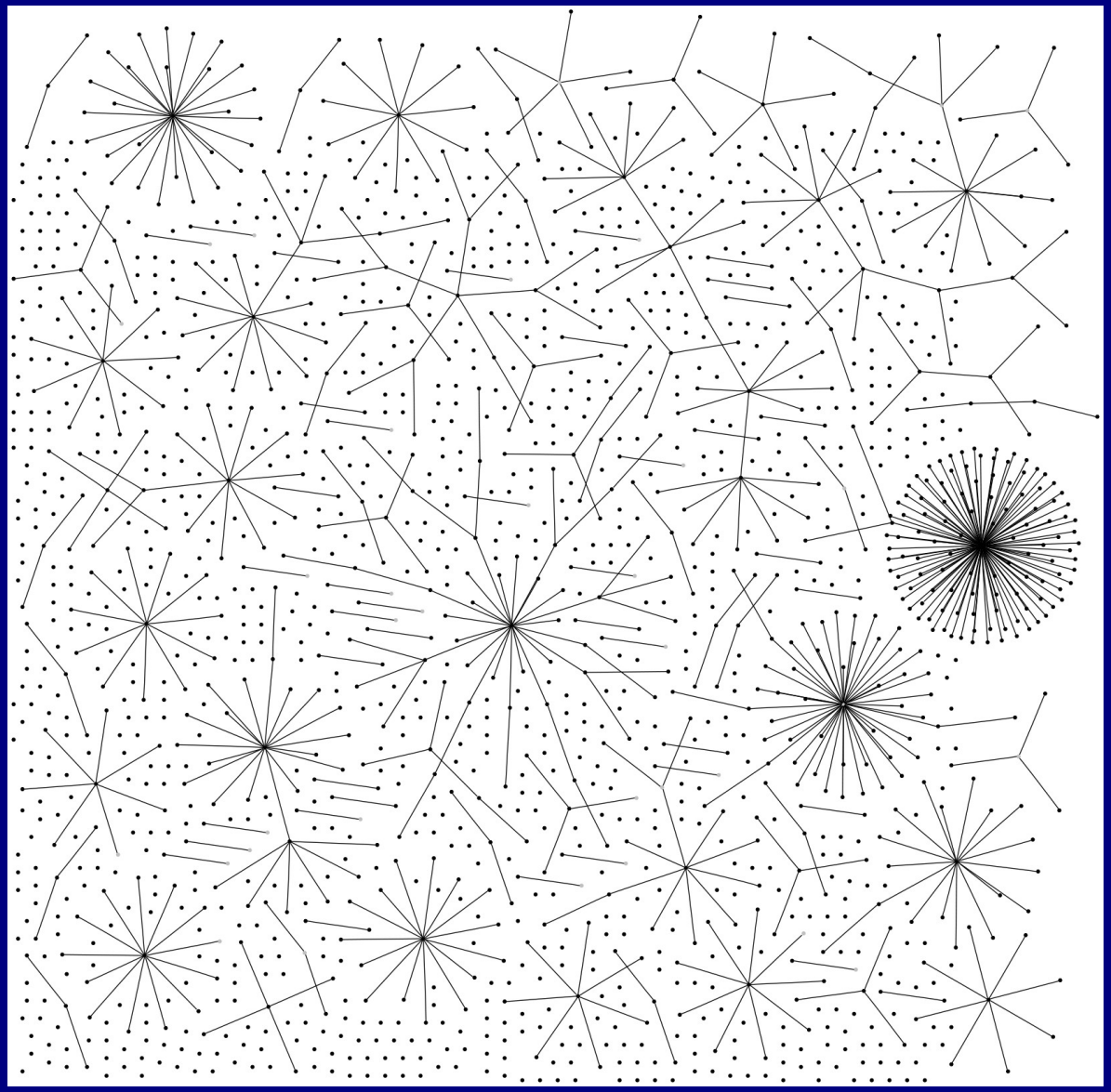
Class Hierarchies

JHotDraw
5.2



Class Hierarchies (2)

Azureus
2.4.0.2



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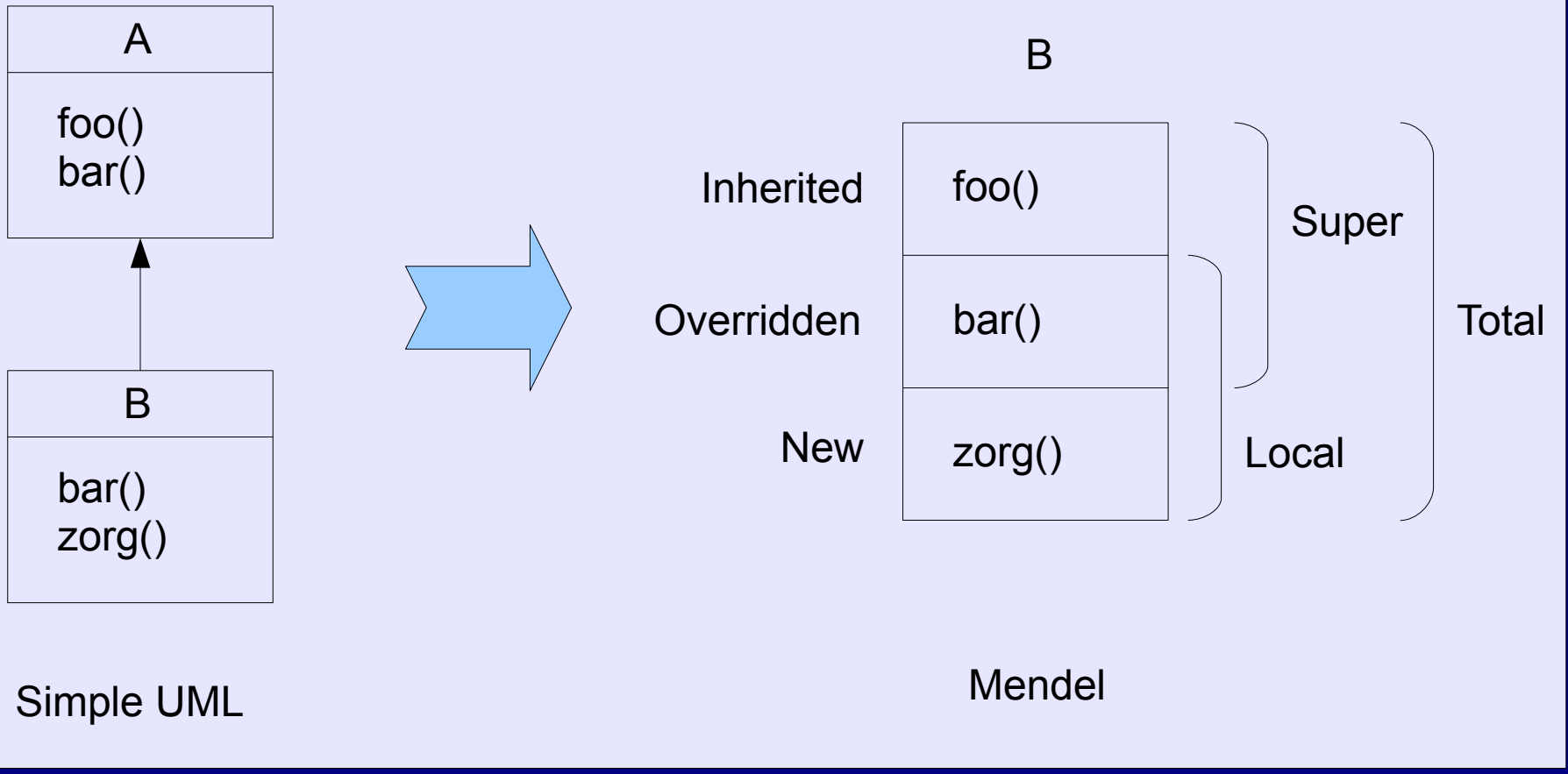
Mendel Approach

- Goal: insights on class hierarchies
  - Interesting classes in their own hierarchy
  - Subclassing behaviors: extending (adding) vs overriding
- Characteristics (requirements) of our approach
  - Early stage in maintenance
  - Intuitive
  - Fast

Mendel: Generic Model



Mendel: Metrics and Rules

- Simple metrics:
  - Based on interfaces = sets of method signatures
  - Computed on a single class or a hierarchy
- Rules for:
  - Selection (threshold)
  - Classification
  - Comprehension (rule of thumb)

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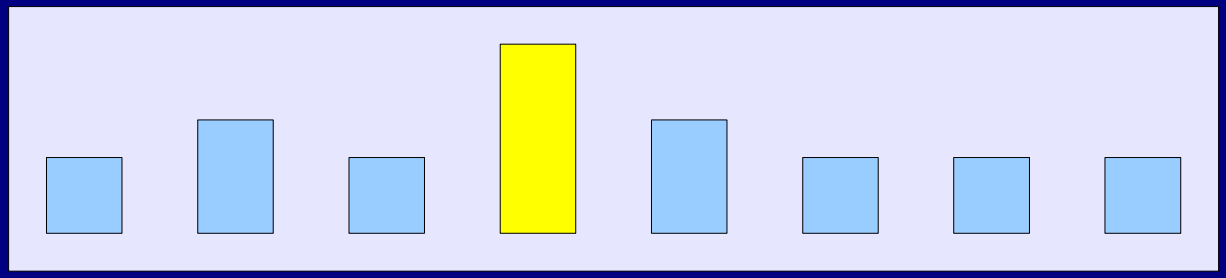
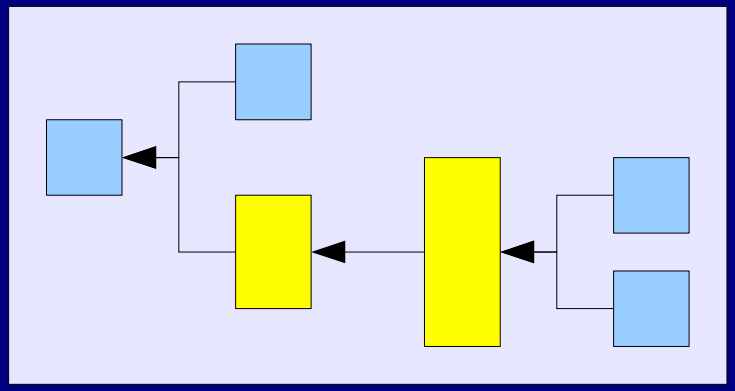
Interesting Classes

- Classes defining a lot of new behaviors
- Large class: overall system



- Budding class: with respect to its hierarchy



- Blooming class: large and budding

Large Class

- Class with a large interface
- Large Class: |Local| > threshold(|Local|)

- JHotDraw
  1. StandardDrawingView (inherits from JPanel), 55 methods
  2. DrawApplication (inherits from JFrame), 53 methods
  3. AbstractFigure (inherits from Object), 34 methods

Budding Class

- Class with a large interface with respect to its hierarchy
- Metrics:
  - Branch Mean Size – bms = |Total| / (DIT + 1)
  - **Novelty Index** – nvi = |Local| / bms(superclass)
- Budding class: nvi > threshold(nvi)

- JHotDraw
  1. AbstractFigure, 3.09
  2. TextFigure, 1.84
  3. PolygonFigure, 1.59

Blooming Class

- Synthesis: combining large and budding
- **Novelty Score** – nvs = |Local| × nvi
- Blooming Class: nvs > threshold(nvs)

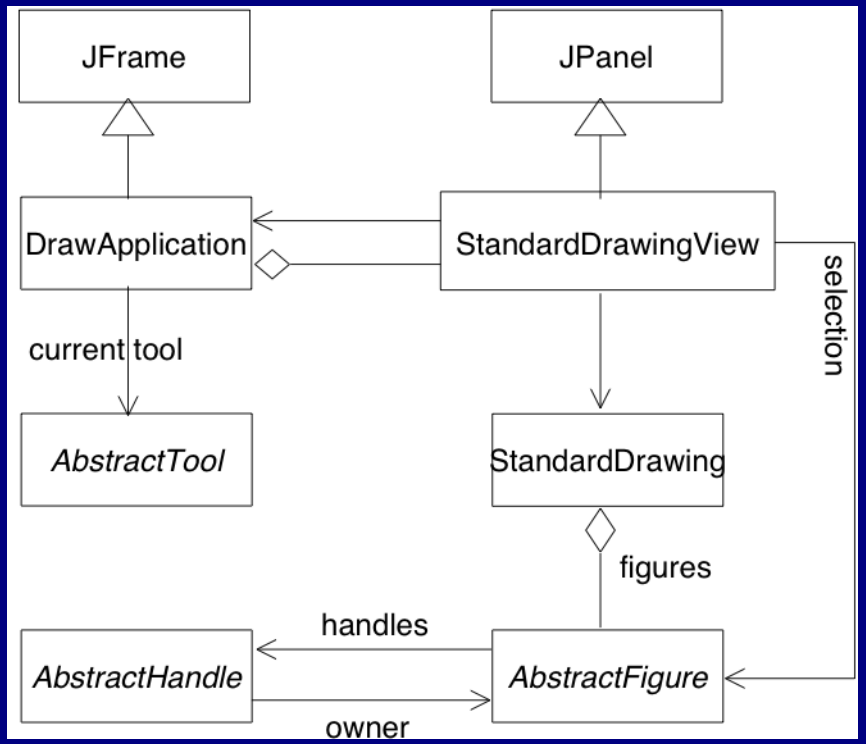
- JHotDraw
  1. AbstractFigure, 105.09
  2. TextFigure, 55.1
  3. LineConnection, 49.55

JHotDraw Overview with Mendel

- JHotDraw 5.2: 148 classes
  - 13 large (9%)
  - 18 budding (12%)
  - 11 blooming (7%)
- Among 11 blooming classes
  - 8 in AbstractFigure hierarchy
  - + DrawApplication, StandardDrawingView, ConnectionTool

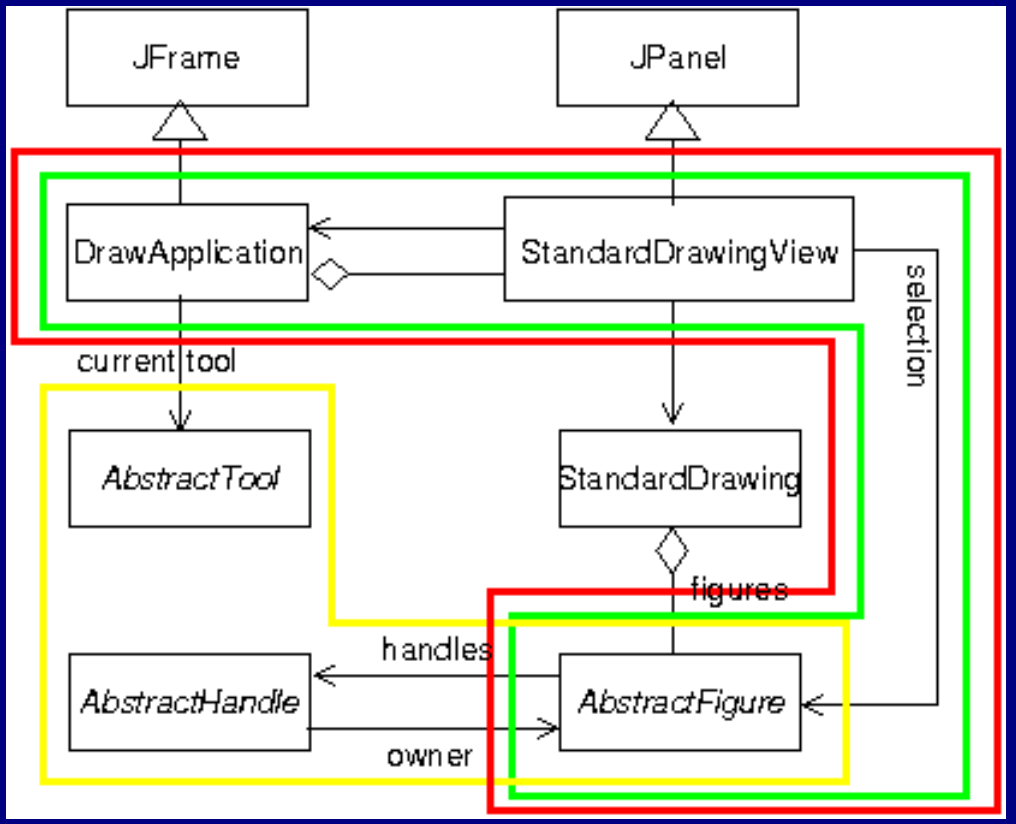
JHotDraw Base Classes

- Given documentation: 6 base classes



Comparison with Documentation

- 5 out of 6 in at least one set
  - AbstractFigure in all 3 sets



Large

Budding

Blooming

What about StandardDrawing?

- Max rank: 16th by |Local| order
- Reason: overrider of CompositeFigure (4th blooming class)
- Conclusion: StandardDrawing to be understood in relation with CompositeFigure

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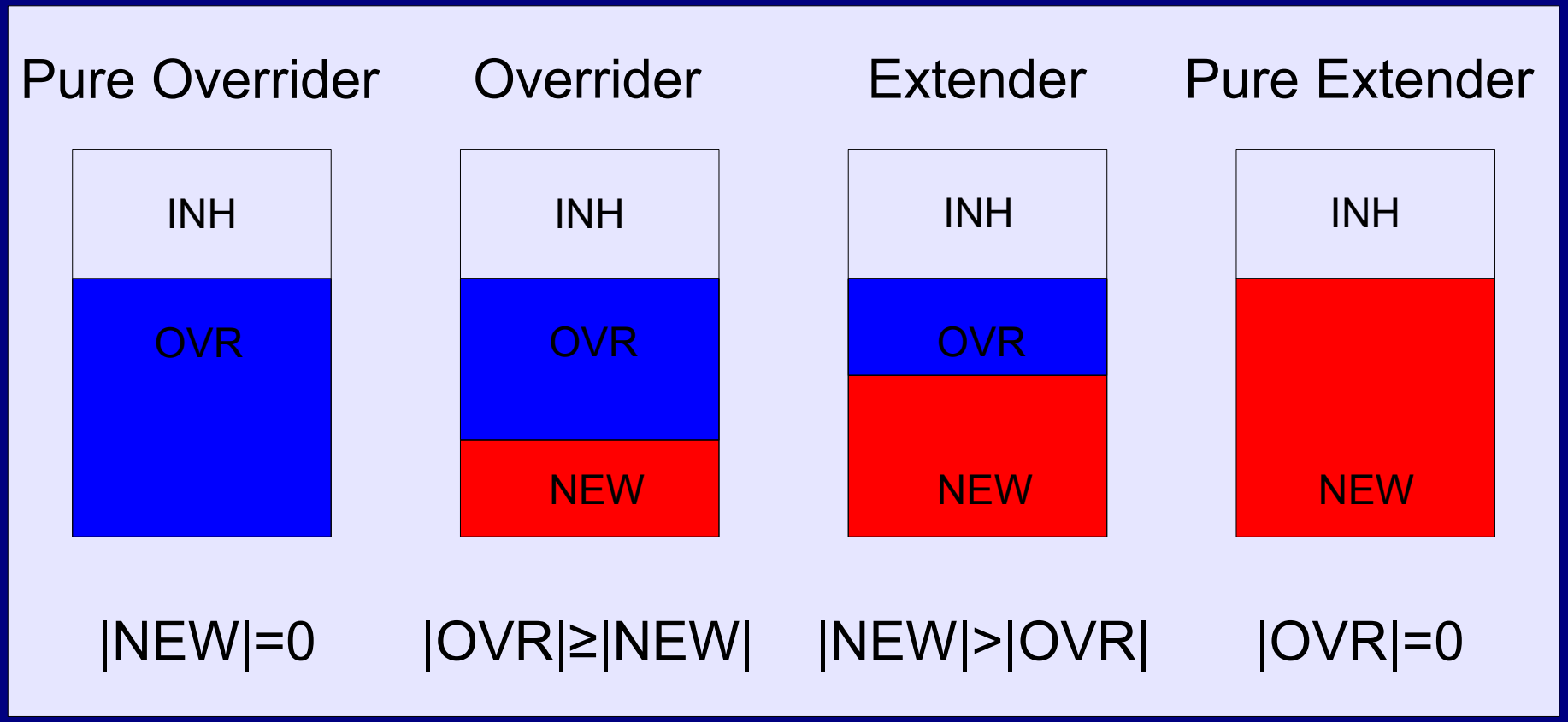
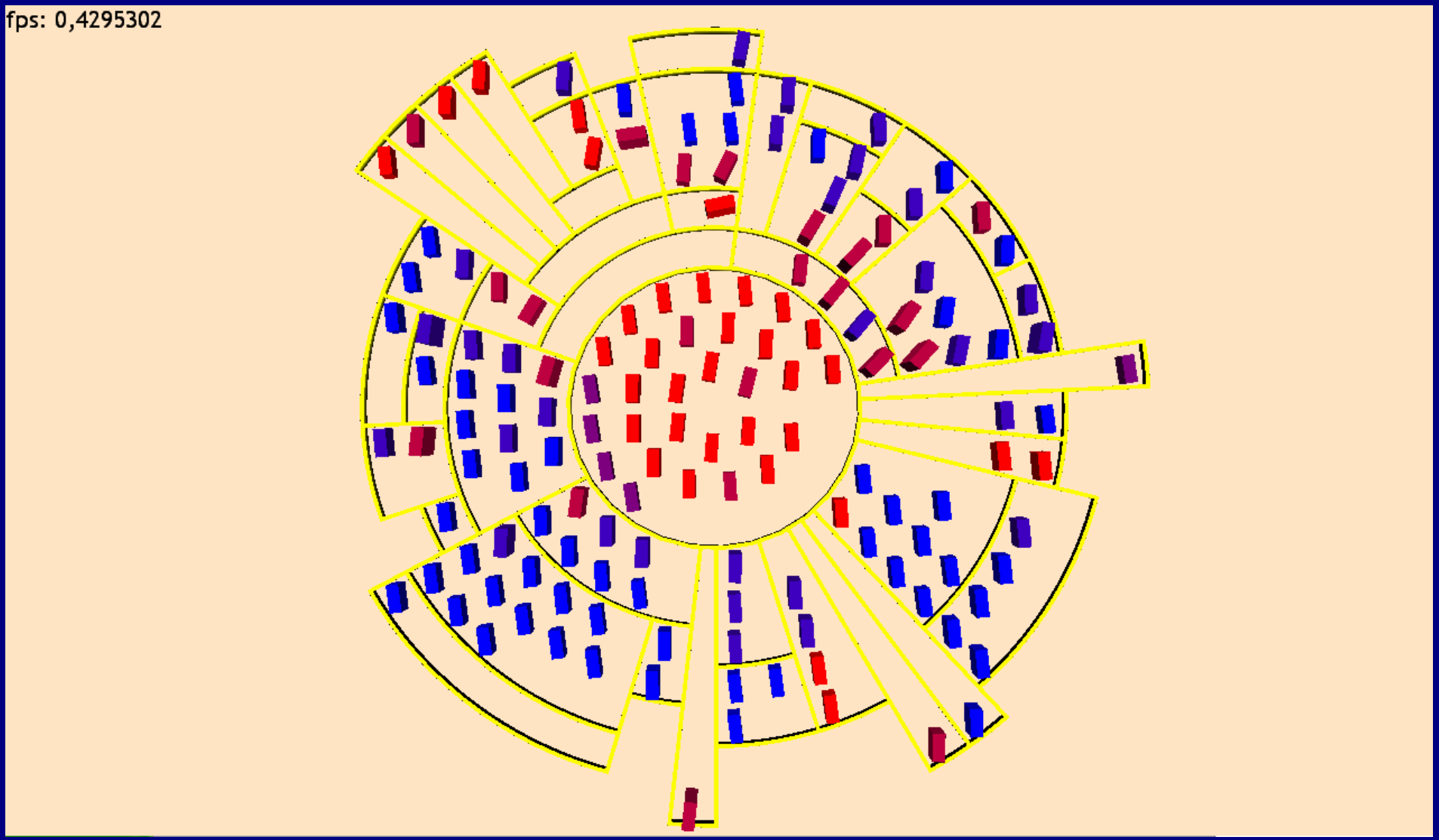
Subclassing Behaviors



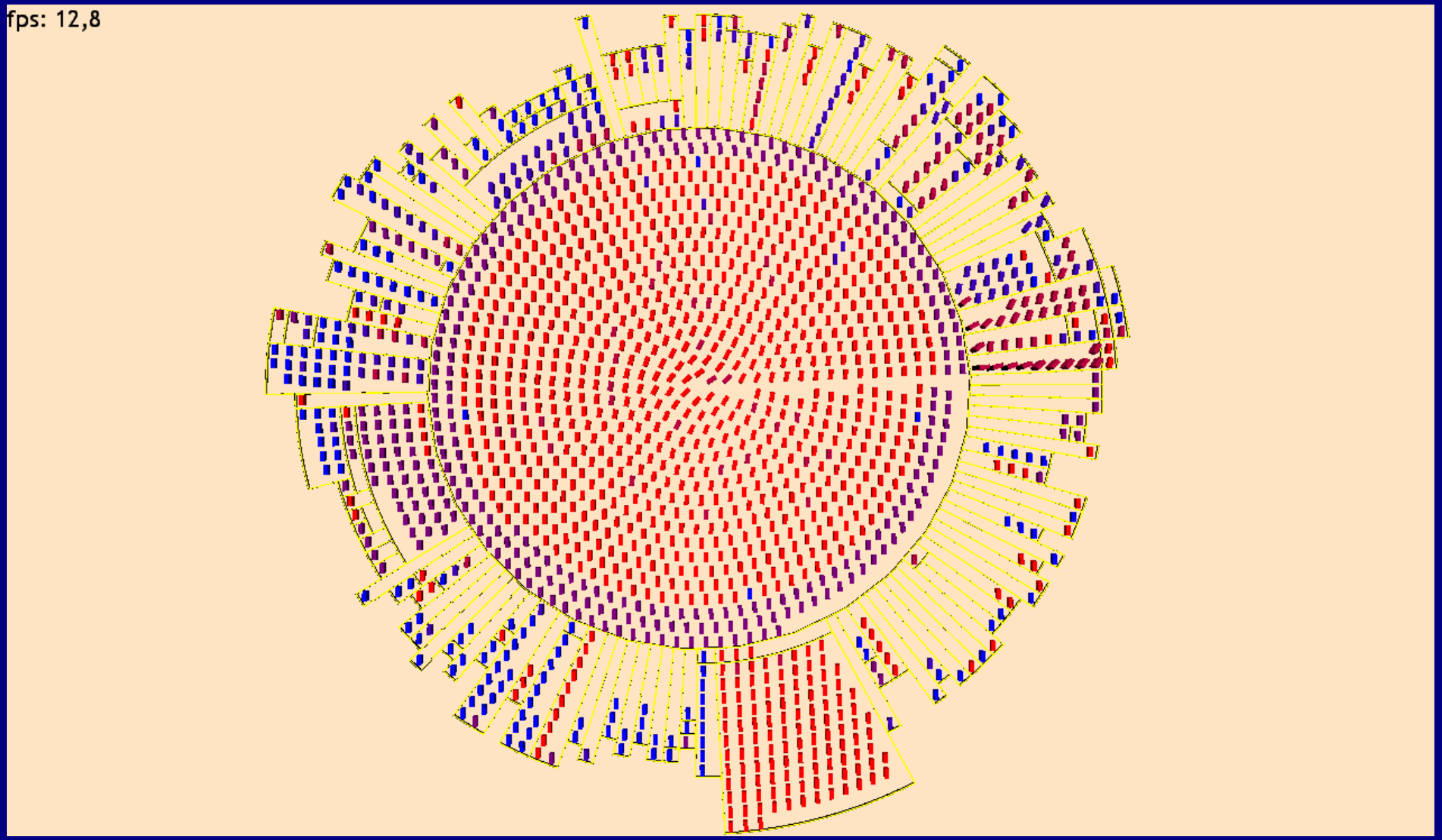
Extender vs Overrider

- Rules of thumb
- Pure extender
  - Adding new methods: no access through superclass
  - Used for itself
  - Implementation inheritance
- Pure overrider
  - Overriding methods
  - Used through substitution to superclass
  - Interface inheritance

JHotDraw in Verso



Azureus in Verso



Implementation in Java

- Tailored for Java
  - BCEL as class files parser
- Performance for Azureus (1681 classes)
  - Standard desktop machine (2Ghz processor, 1Go memory)
  - 9 seconds

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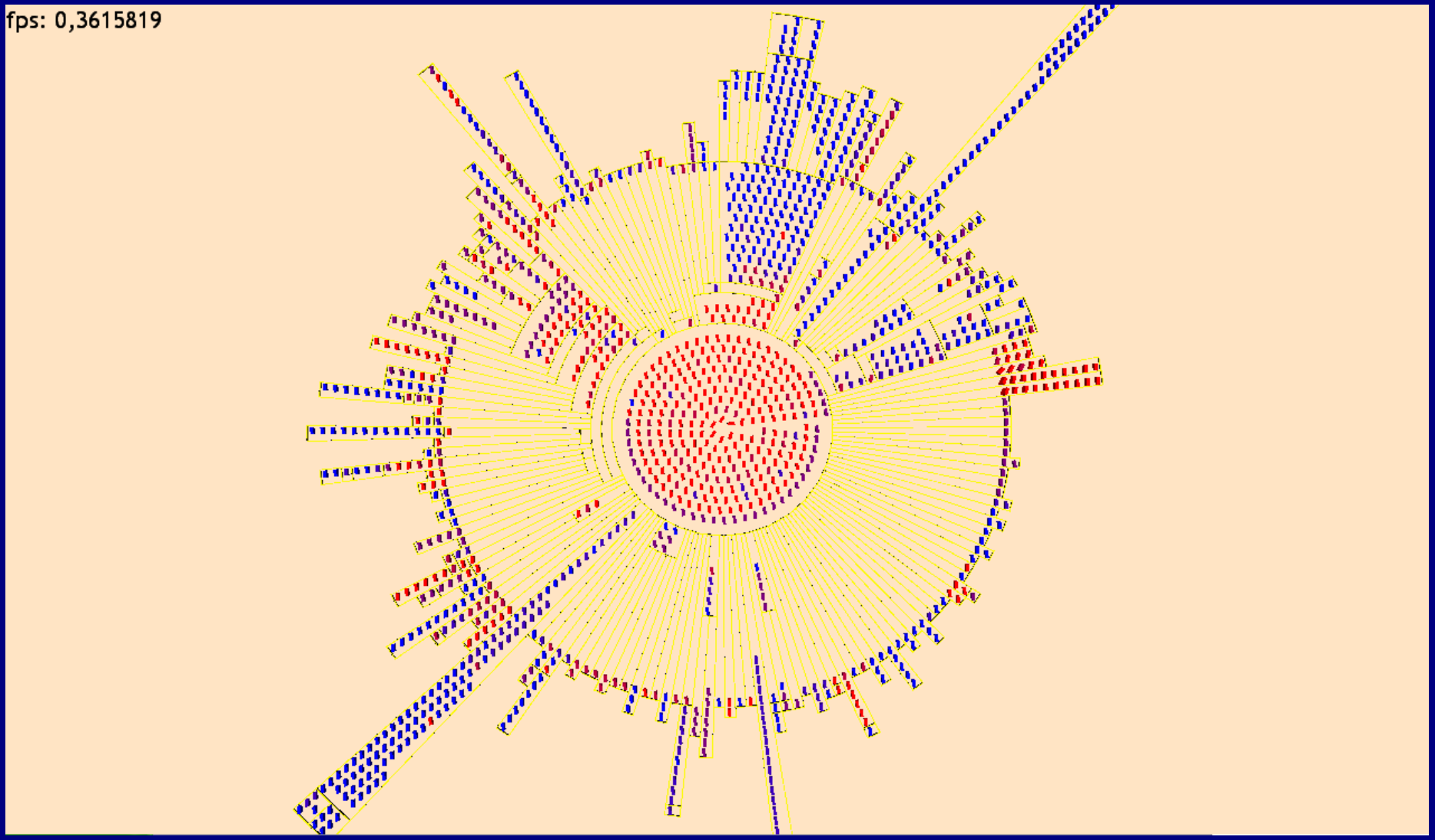
Conclusion

- Mendel
  - Generic model
  - Simple metrics
  - Rules
- Results
  - Quick insights on interesting classes and concerns
    - Large, budding, blooming: different views of interesting classes
    - Concerns: keywords in classnames
  - Different usage of inheritance in programs
    - Some leaned to extending (Log4J, Azureus)
    - Others to overriding (JHotDraw, ArgoUML)

Future Work

- Family analysis
  - Family = class + children
  - Common behavior and interface
- Visualisation
  - Hierarchy representation
  - Visual patterns

ArgoUML in Verso



Blooming Classes Selectivity

- Log4J: 2 of 206 (1%)
  - LogBrokerMonitor (104 methods), Category
  - Budding set: Appender hierarchy
- ArgoUML: 18 of 1431 (1%)
  - 2 very big classes: NSUMLModelFacade, FacadeMDRImpl
  - Design choice: Facade design pattern
  - Keywords in class names: two products, normal and MDR
- Azureus: 54 of 1681 (3%)
  - Keywords in class names: three concerns, download, peer, DHT

Behaviors Discrimination

- Two categories
  - JHotDraw and ArgoUML: overriding behaviors
    - Large proportions of *Pure Overriders*
  - Azureus and Log4J: extending behaviors
    - Azureus: 58% of classes are *Pure Extenders*