Reverse Engineering with Logical Coupling

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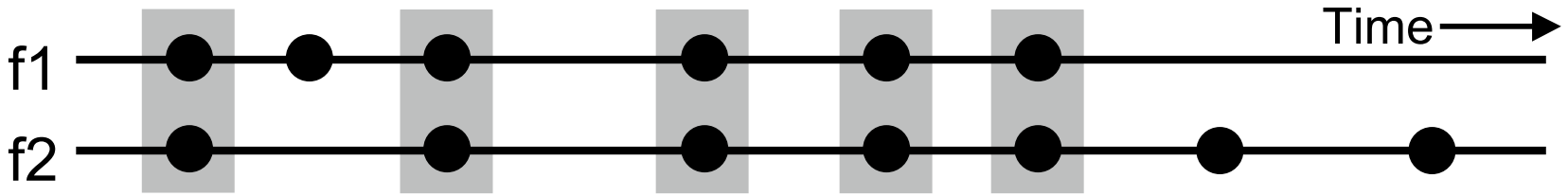
Evolutionary Information

- Important resource for understanding legacy software systems
  - Infer causes of problems
  - Detect candidates for reengineering activities
- **Complementary**: Information not present when considering only one version of the system
- **Challenging**:
  - Facts have to be reconstructed
  - Techniques are needed for processing and understanding large amount of data

Logical Coupling (LC)



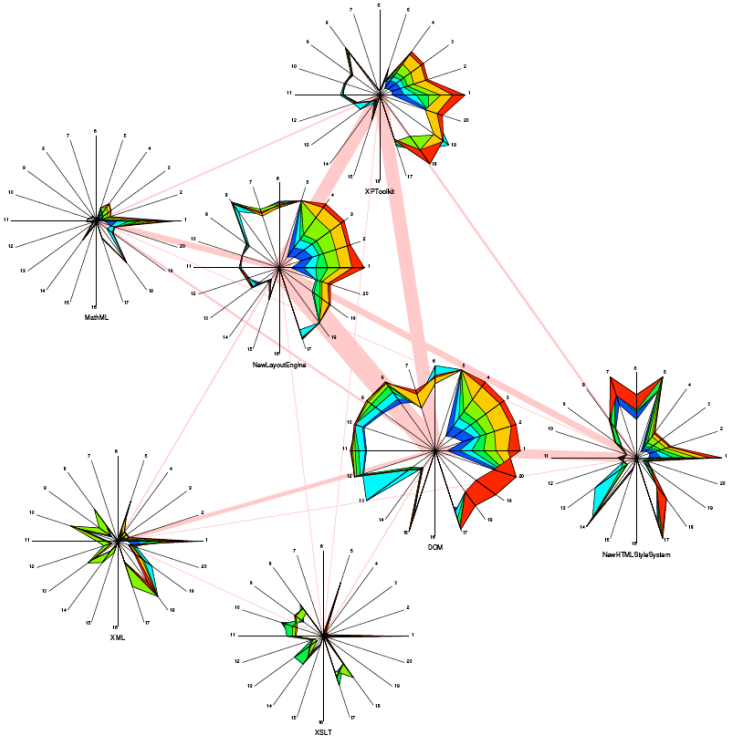
- Implicit dependencies between artifacts observed to change together
- Introduced by Gall *et. al.* in [1]
- Benefits
  - Lightweight
  - Visible only in the evolution, not in the code or documentation
  - Orthogonal to structural analysis

[1] *Gall et. al.* Detection of Logical Coupling Based on Product Release History. ICSM 1998

Current Approaches to LC

Architecture level (*e.g.* [2])

- Dependencies among modules or subsystems
- Problem: Loss of detailed information



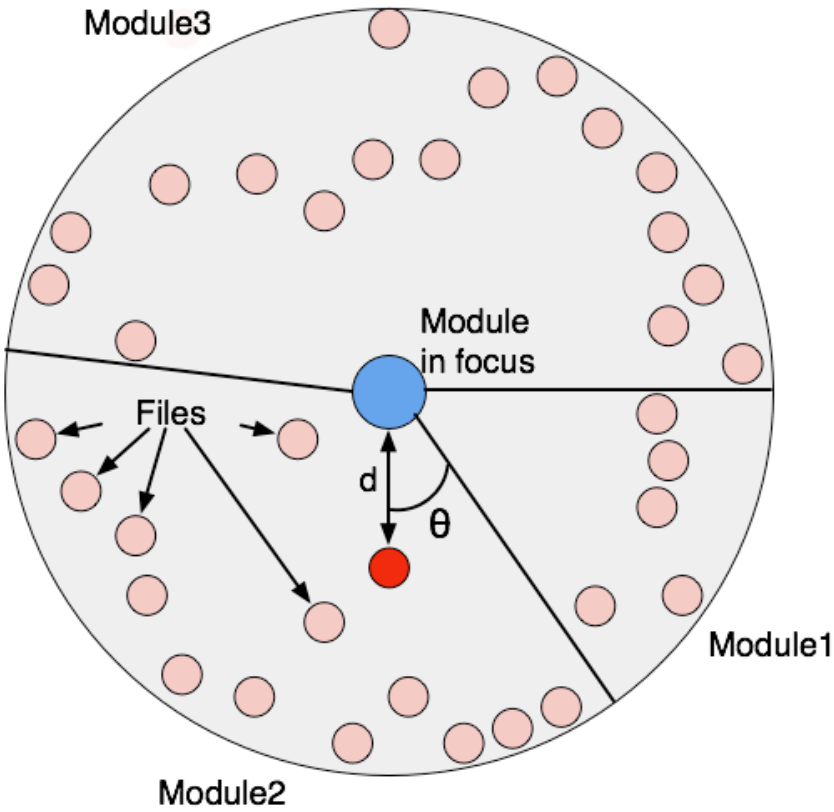
File (or finer) level (*e.g.* [3])

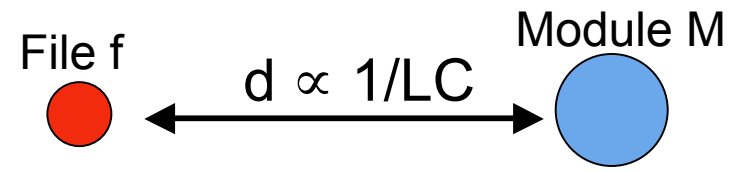
- Predict entities which are likely to be modified
- Problem: No global view of the system

[2] *Pinzger et. al.* Visualizing Multiple Evolution Metrics. SoftVis 2005
[3] *Zimmermann et. al.* Mining version histories to guide software changes. ICSE 2004

The Evolution Radar

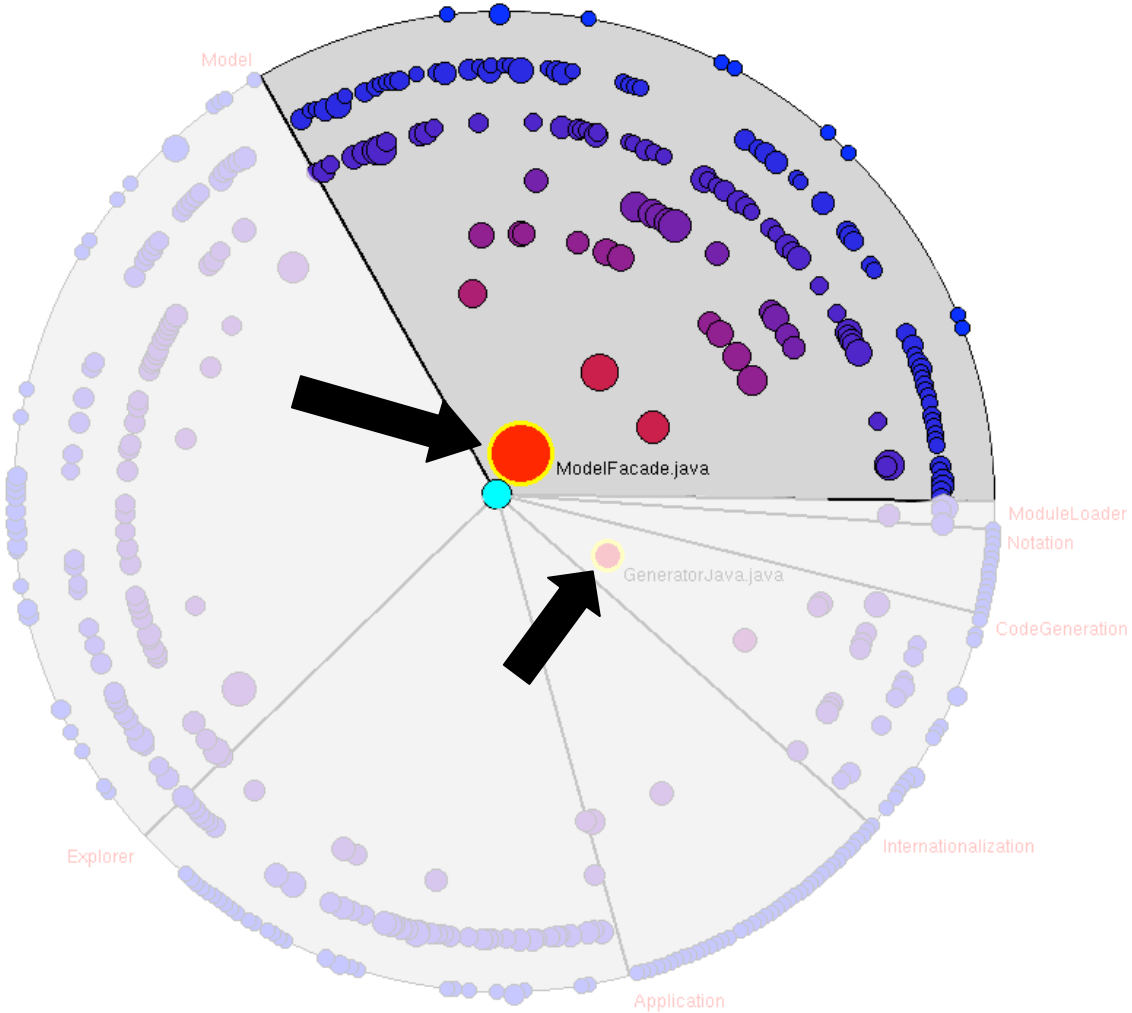
- The module in focus (or reference module) is placed in the center
- All the other modules are shown as sectors
- For each module all its files are rendered as colored circles and positioned using polar coordinates:
  - **d**: inverse proportional to LC
  - θ: alphabetical sorting and uniform distribution
- Metrics can be mapped on the size and color of figures
- LC between two files is the number of “shared” commits
- LC between a file and a module is defined by means of a group operator





$$LC(M, f) = \max_{f_i \in M} LC(f_i, f)$$

Evolution Radar Exemplified



- LC between a module and all the other module
- How the coupling is structured in terms of files
- Files most coupled with the module

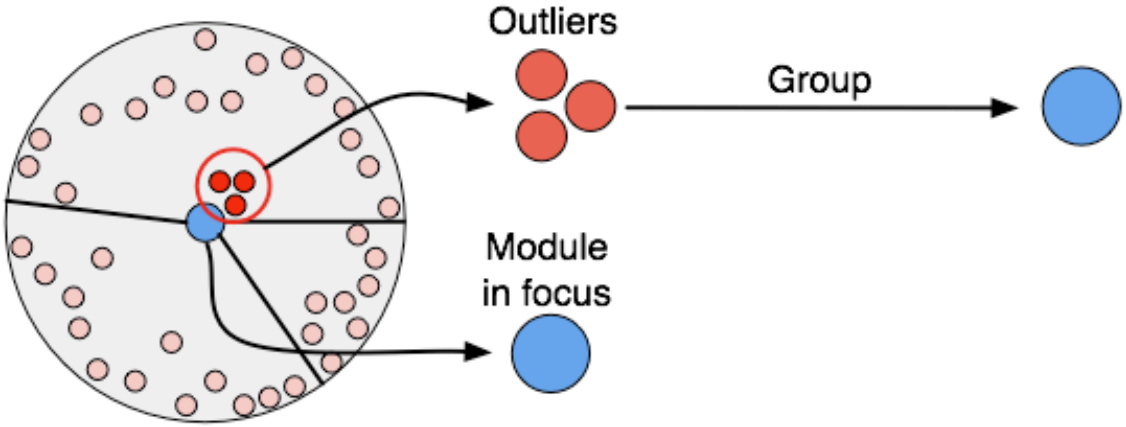
But a static visualization is not enough for analyzing a system…

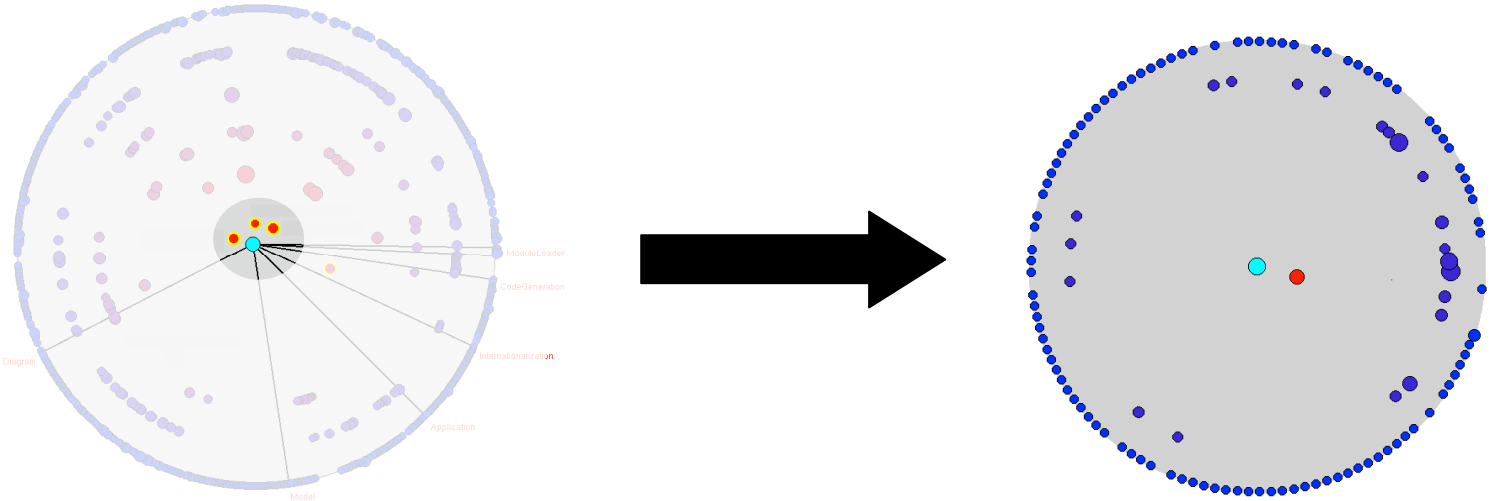
Interacting with the Radar

- Basic interaction
  - Any entity in the visualization (files and module in focus) can be inspected
    - Source code
    - Commit-related information
    - Contents
- Advanced interaction
  1. Spawning
  2. Moving trough time
  3. Tracking

Spawning

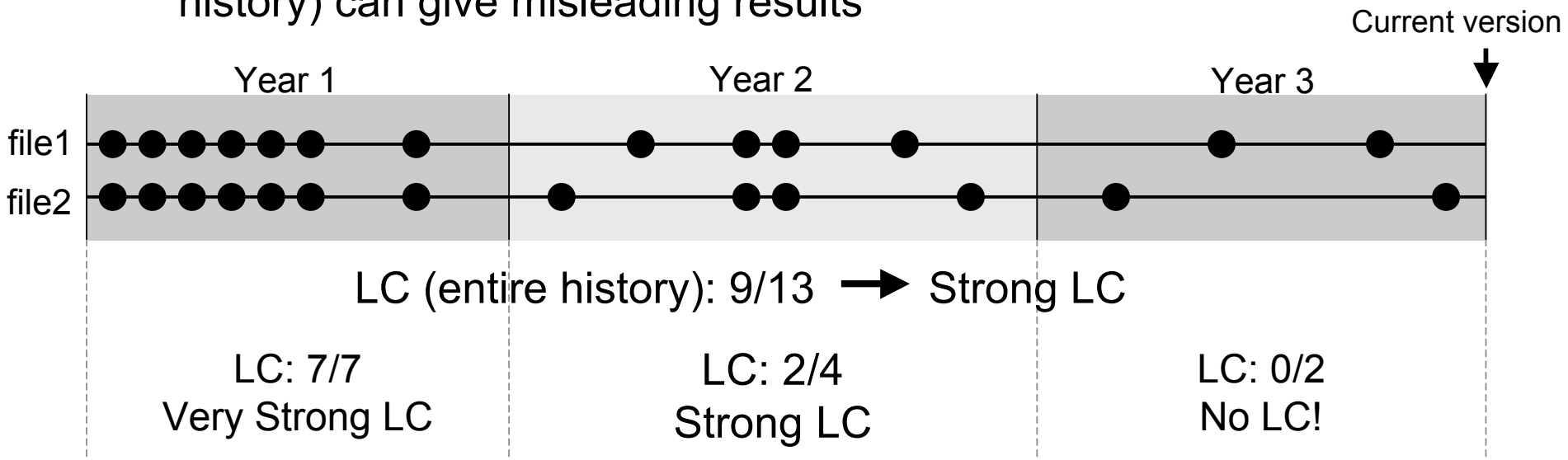
To understand which files are coupled with selected files in the module in focus





Moving Through Time

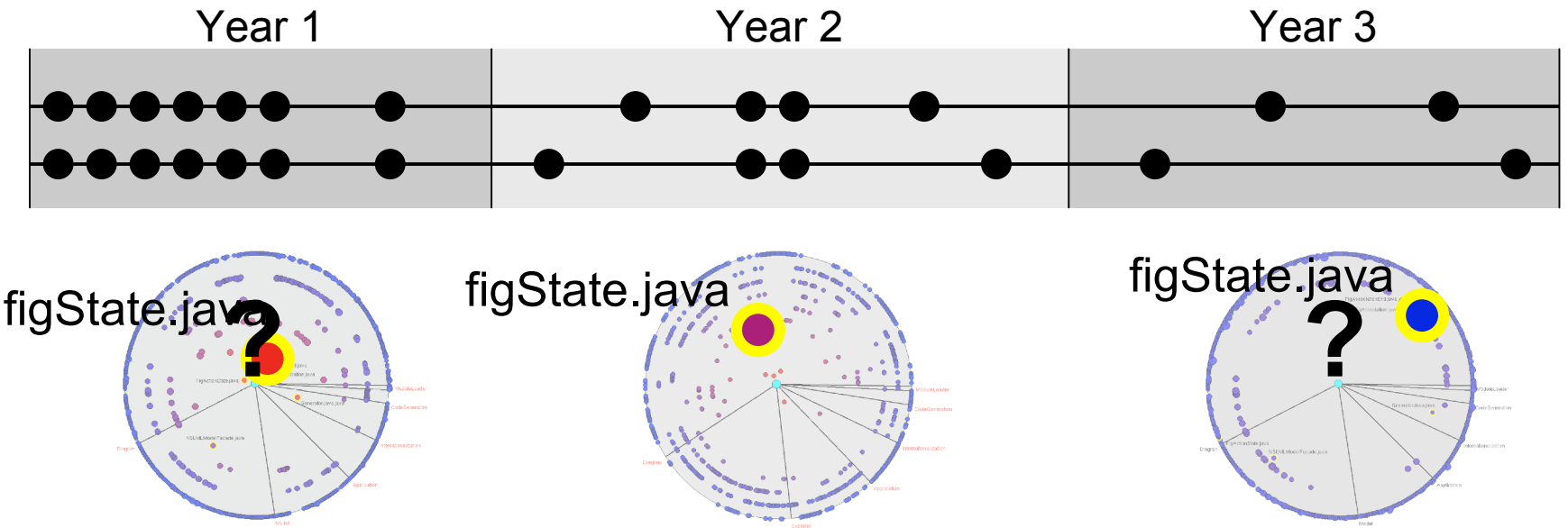
- **Problem**:
  - The LC value is time dependent
  - Summarizing the LC in a single value (*i.e.* consider the entire history) can give misleading results



- **Solution**:
  - LC computed according to settable time interval
  - An Evolution Radar displayed for each time interval
  - A time slider is used to “move through time”

Tracking

- **Problem**: How do we keep track of the same entity in different time intervals, *i.e.*, in different radars



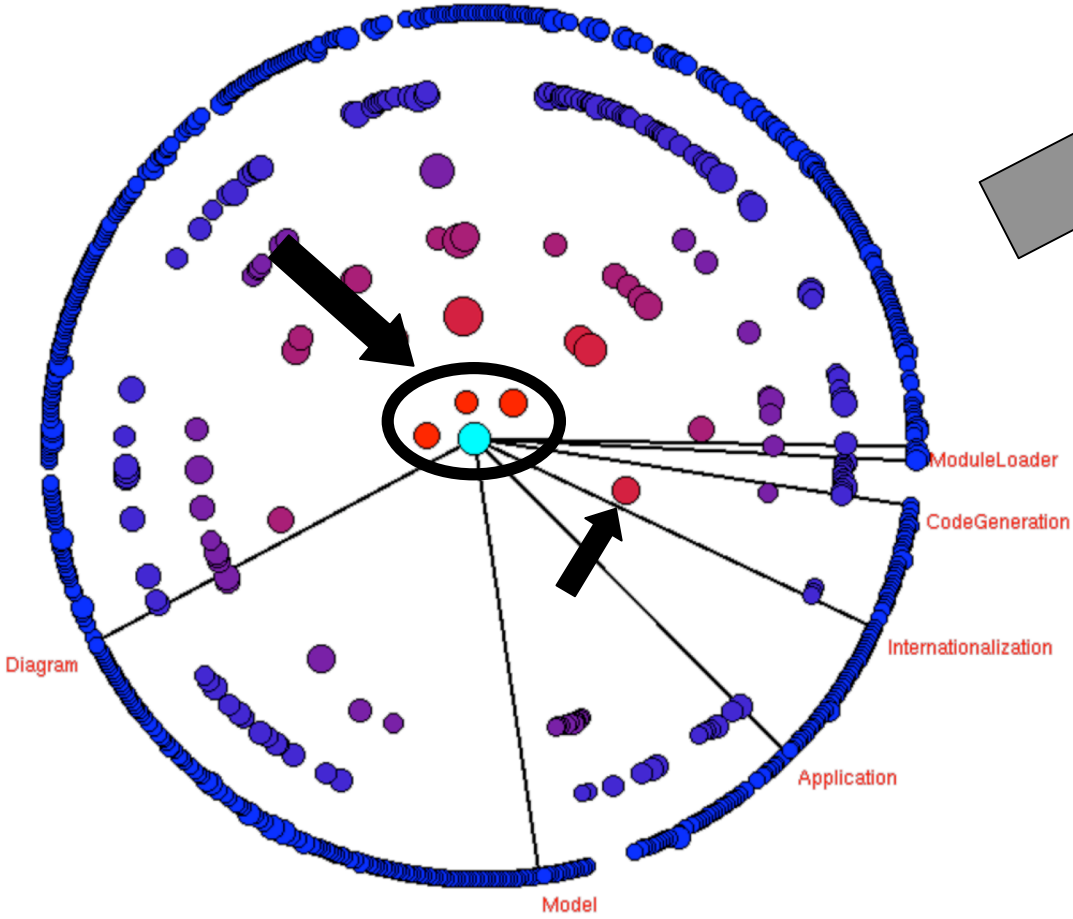
- **Solution:** Files selected in one radar are highlighted (yellow border and name) in all the other radars

Validation: ArgoUML

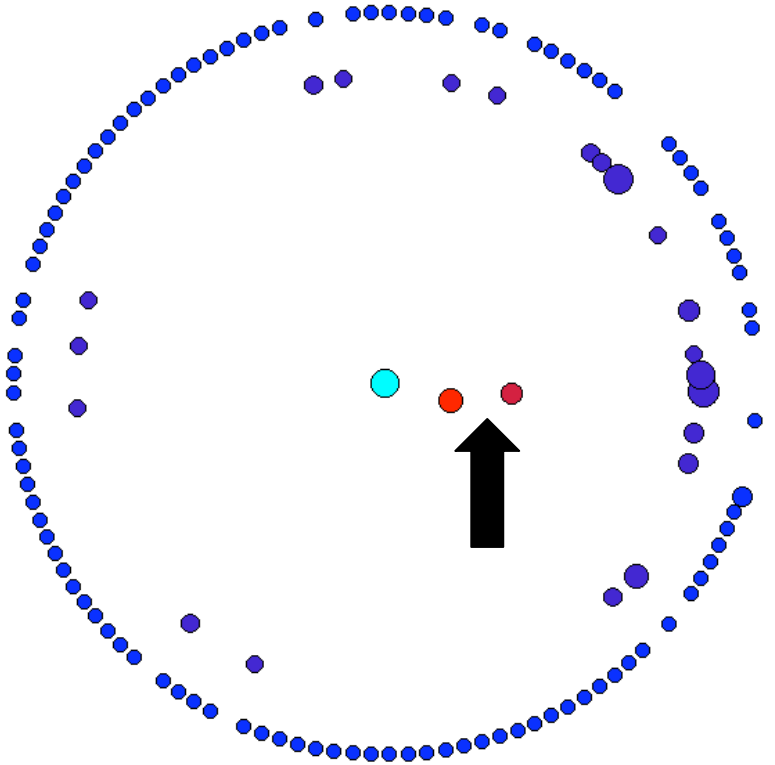
LOC	Files	Commits	Time interval
250K	4300	46'000	2000-2005

- Methodology
  - Consider time intervals of 6 months
  - Apply one evolution radar per time interval
  - Metrics mapping
    - Color and position: LC (6 months)
    - Size: number of lines changed (6 months)

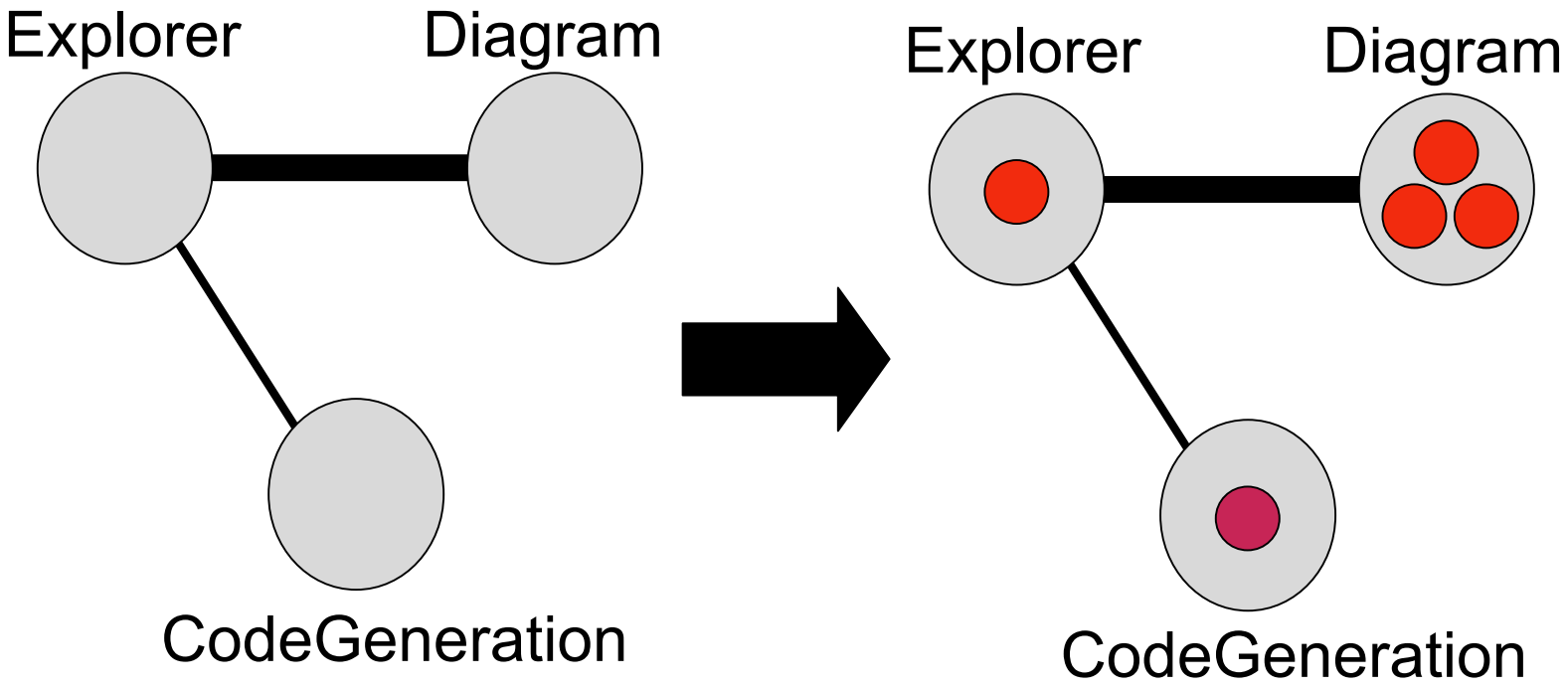
Explorer: Aug-Dic 2005



Spawning

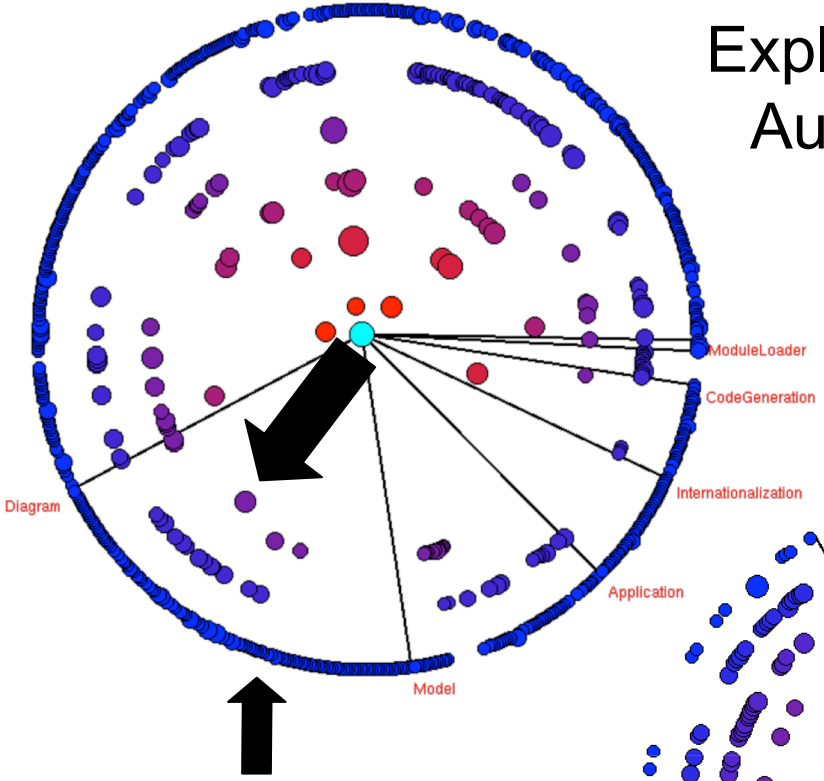


Information crystallization



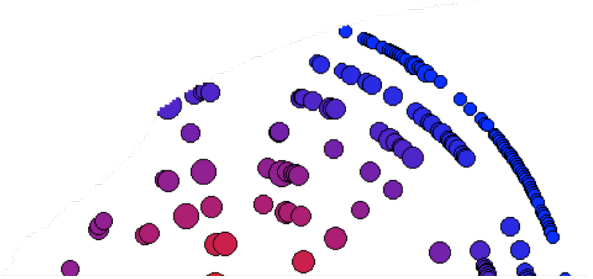
- Dependencies between modules are simplified to dependencies between small sets of files.
- These files are candidates for reverse engineering

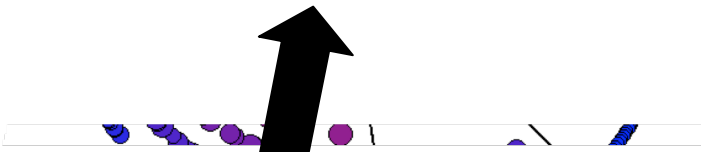
The Evolution of ModelFacade



Explorer in focus
Aug-Dic 2005

Explorer in focus
Aug-Dic 2004





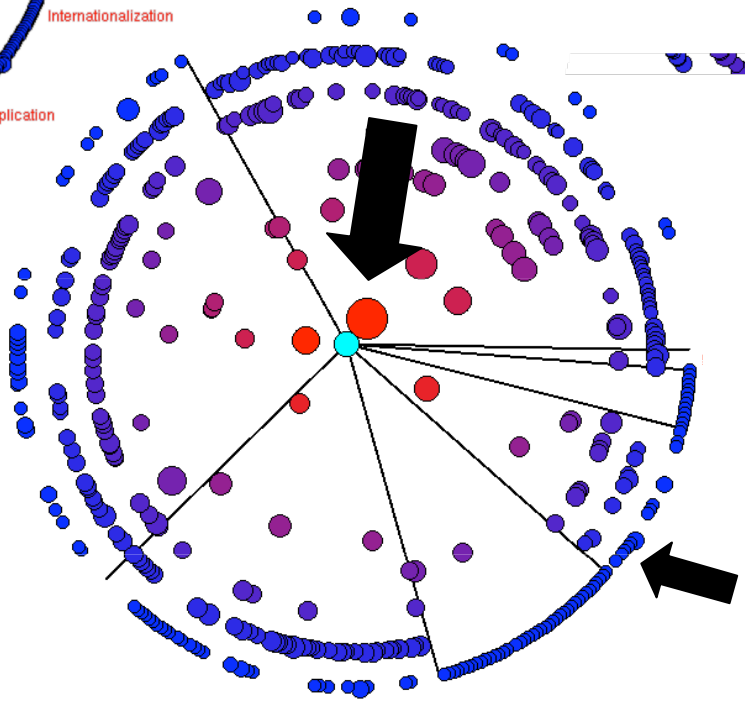
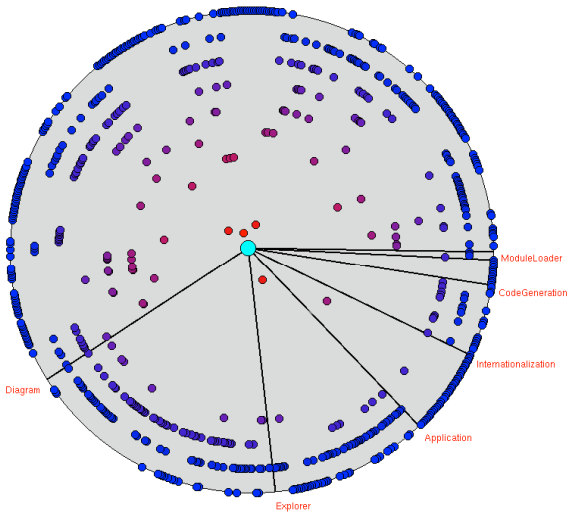


Diagram in focus
Aug-Dic 2004

Conclusion

The Evolution Radar visualizes **integrated** logical coupling information. It shows:

- Dependencies at the module level
- The structure of these dependencies in terms of files, by rendering the files themselves



Pro

+ Interactivity and control of time
+ Scalability
+ Does not suffer from overplotting
+ General technique applicable to any groups of entities given a distance measure

Cons

– Need an authority system decomposition
– Finest granularity: files
– May suffer from the outliers problem