Modular Moose

A platform for in-the-large & in-the-small reverse engineering

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RMod

Agenda

- Reverse engineering in the large/small
- Moose, some background
- Composable Meta-Model
- Integrated Reverse Engineering Environment
- Conclusion

Agenda

Reverse engineering in the large/small

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Conclusion

Software maintenance





“Today, you will use 13 COBOL applications”
[P. Nieuwbourg, 2012]

To remain useful, systems must evolve

- Adaptation to new needs (GUI, cloud, …)
- Prepare for future evolution

Software maintenance

Windows NT 3.1 (1993)

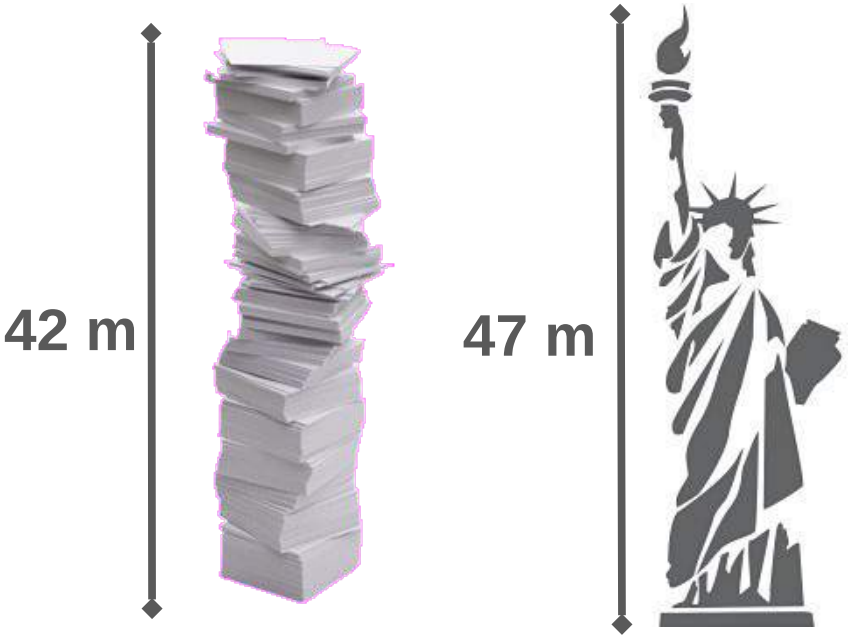
≃ 4 a 5 MLOC

Windows server 2003

≃ 50 MLOC

Windows 10

???

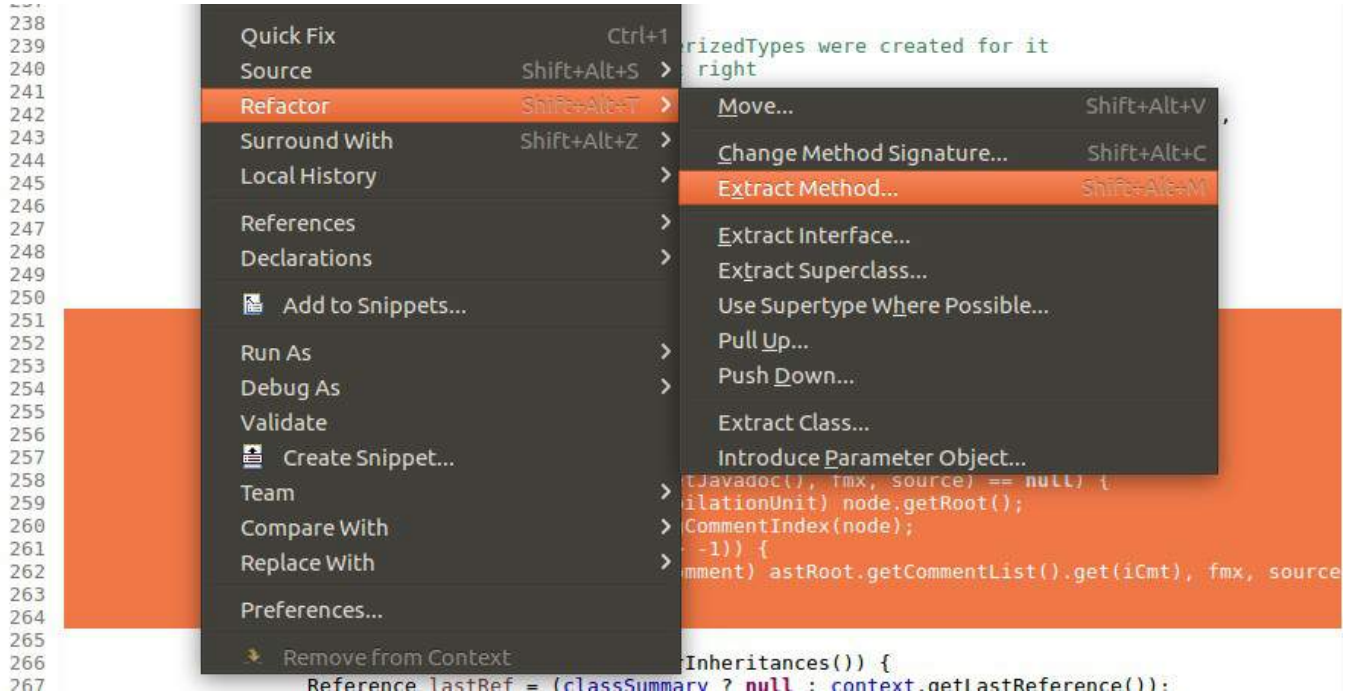


Software maintenance

- Ever living systems
- Intrinsic to software
- Involves understanding a mathematical model (program)
- Tools are needed

Reverse engineering in the large/small

Reverse engineering in the small



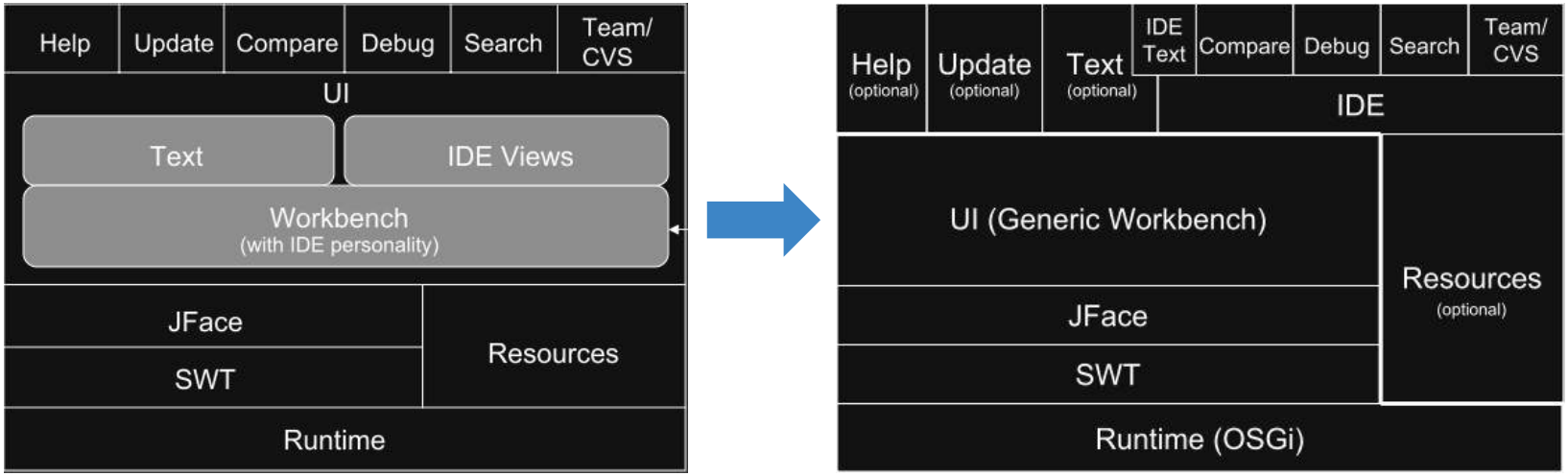
Reverse engineering in the large/small

- Reverse engineering in the small
  - On few entities (<10)
  - Relevant code fits on 1 sheet of paper
  - Complete understanding of each entity

Reverse engineering in the large/small

Reverse engineering in the large

Eclipse v2.1 (Extensible IDE) v3.0 (Rich Client Platform)



Reverse engineering in the large/small

- Reverse engineering in the large
  - Restructure architecture
  - Break a big class
  - Introduce a design pattern (e.g. MVC, Hybernate)
  - Migrate to a new library version
  - ...

Reverse engineering in the large/small

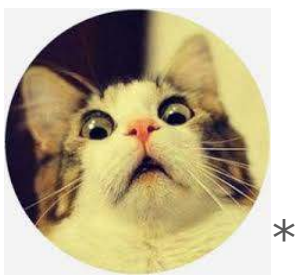
- Reverse engineering in the large
  - Can/Should occurs regularly (≠ often) in the life of a system
  - On many entities (tens, hundreds) / all system

Reverse engineering in the large/small

- Reverse engineering in the small
  - Detailed understanding
  - Instructions, AST
- Reverse engineering in the large
  - High level view on the system (but details matter)
  - Packages, classes, dependencies

Reverse engineering in the large/small

- Reverse engineering in the small
  - Detailed understanding
  - Instructions, AST
- Reverse engineering in the large
  - High level view on the system (but details matter)
  - Packages, classes, dependencies
- + generic tools



* Frightened kitten

Agenda

Reverse engineering in the large/small

Moose, some background

Composable Meta-Model

Integrated Reverse Engineering Environment

Conclusion

Moose, some background

A platform for software analysis

Based on a generic meta-model (Famix)

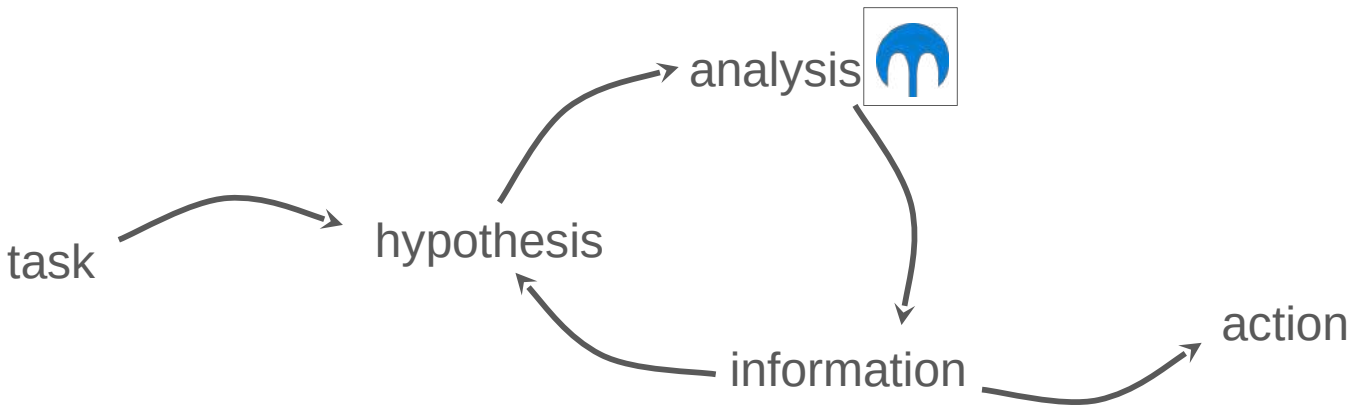
Developed since 1996

https://github.com/moosetechnology/moose-wiki

https://github.com/moosetechnology

Moose, some background

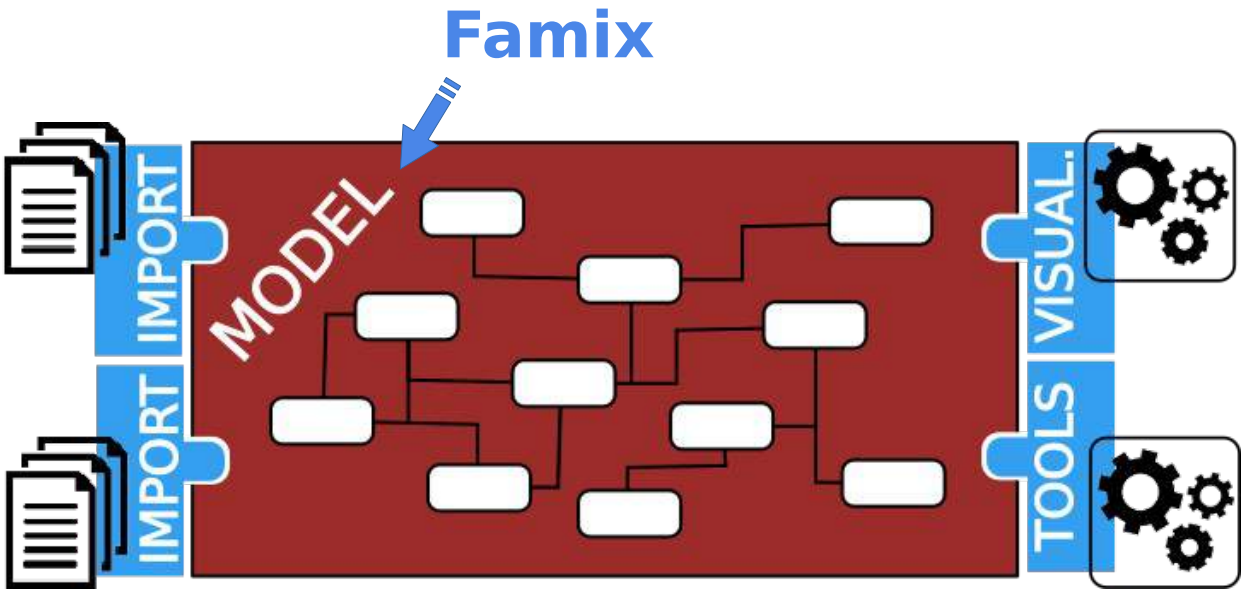
A platform for software analysis



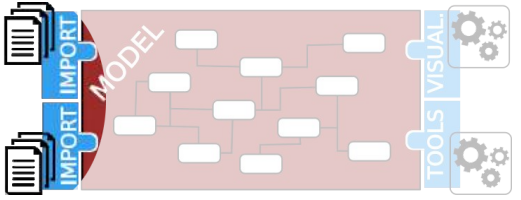
Fast cycle by fast development of new analyses

Moose, some background

A platform for software analysis

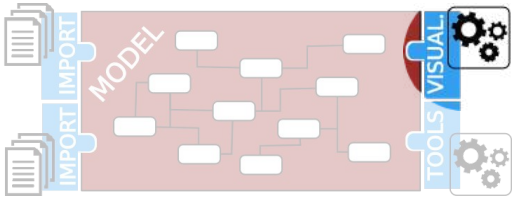


Moose, some background



- Importers
  - Populate a model from existing documents
  - Source code (4D, Ada, C/C++, COBOL, Fortran, Java, Mantis, Pharo, PowerBuilder, SQL, TypeScript, VBA, ...)
  - HTML, XML, CSV, ...
  - Bugs, authors, commits

Moose, some background



Visualizations

Roassal: DSL to script visualizations

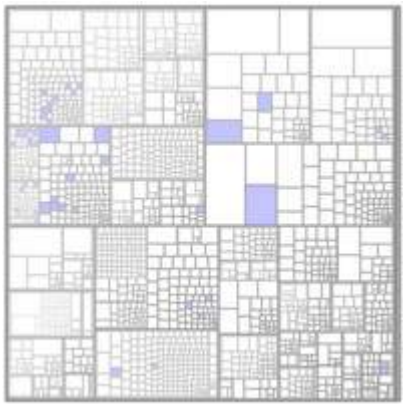
- “Agile Visualization” : explore data through visualizations
- http://agilevisualization.com/

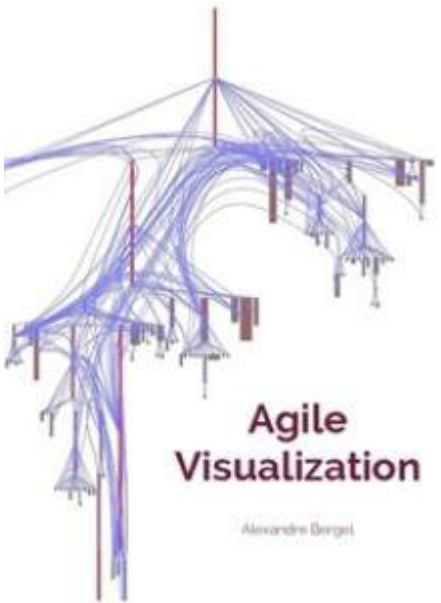
Telescope: Tool with configurable predefined visualizations

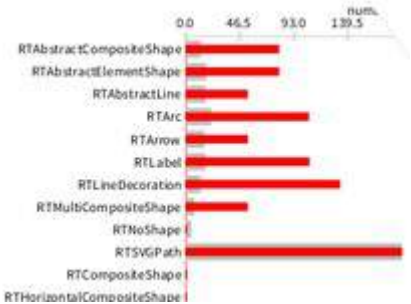
- Rendering with Roassal
- Rendering with Cytoscape (JavaScript)

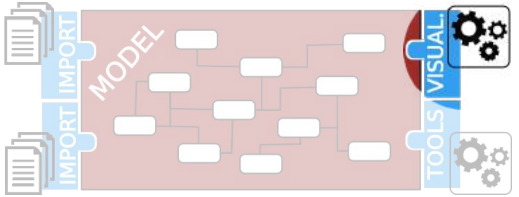
Moose, some background

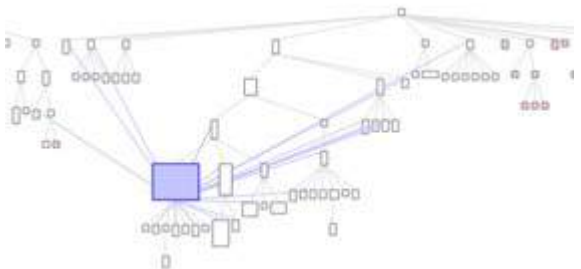
Visualizations



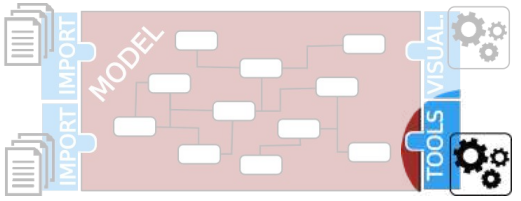








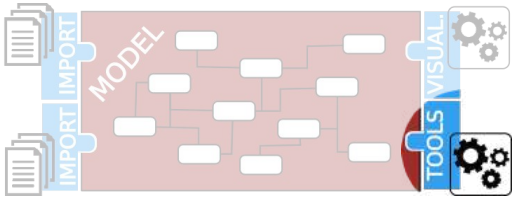
Moose, some background



Tools

- MooseQuery: DSL to query a model
- Software engineering metrics (cohesion/coupling, Chidambler & Kemerer metrics, LCOM, cyclomatic complexity, ...)
- Tagging (labels and/or virtual entities)
- Data Mining algorithms

Moose, some background



Moose Query

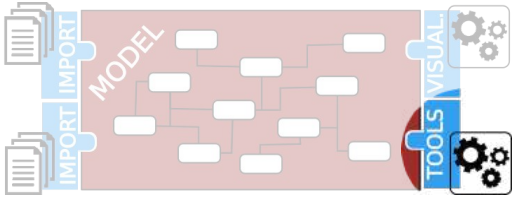
https://moosequery.ferlicot.fr/

API to programmatically query FamixNG models

- Entities respecting some condition (name, metrics, …)
- Containment navigation (parent, children)
- Dependency navigation (clients/providers, invoked methods, …)

Moose, some background

Moose Query



Java analysis: “All provider packages for package *p* via method calls?”

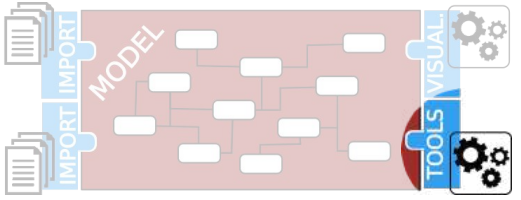
```
(p queryOutgoing: FamixInvocation) atScope: FamixPackage
```

SQL analysis: “All stored procedures accessing a given table column *c*?”

```
c queryIncomingDependencies atScope: FamixSQLStoredProcedure
```

Moose, some background

Moose Query



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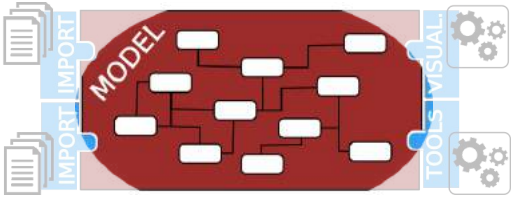
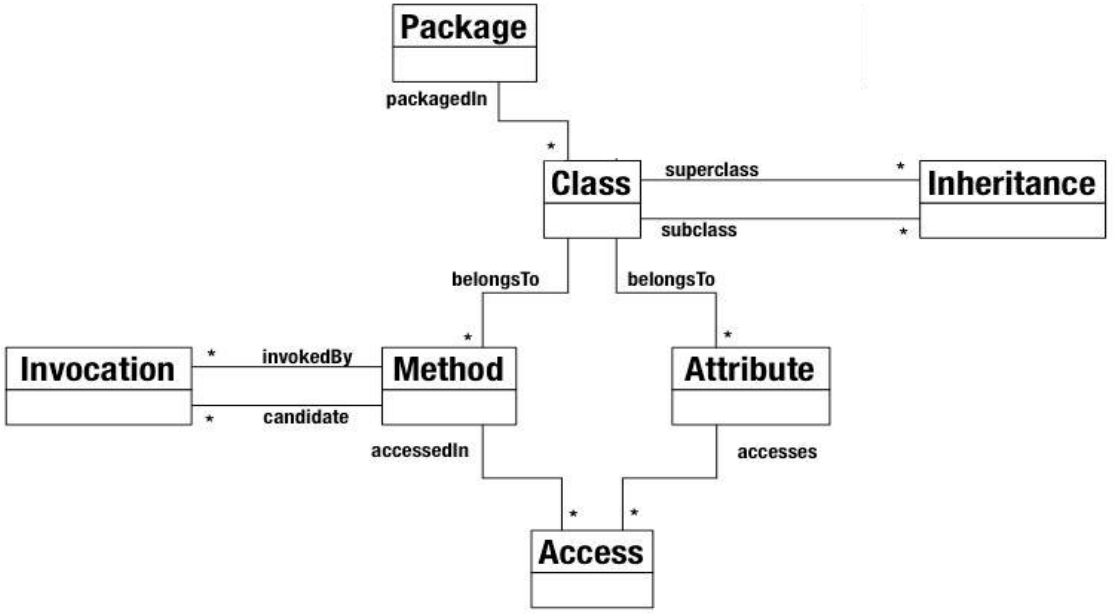
For experts

Moose, some background

Generic software meta-model (Famix)

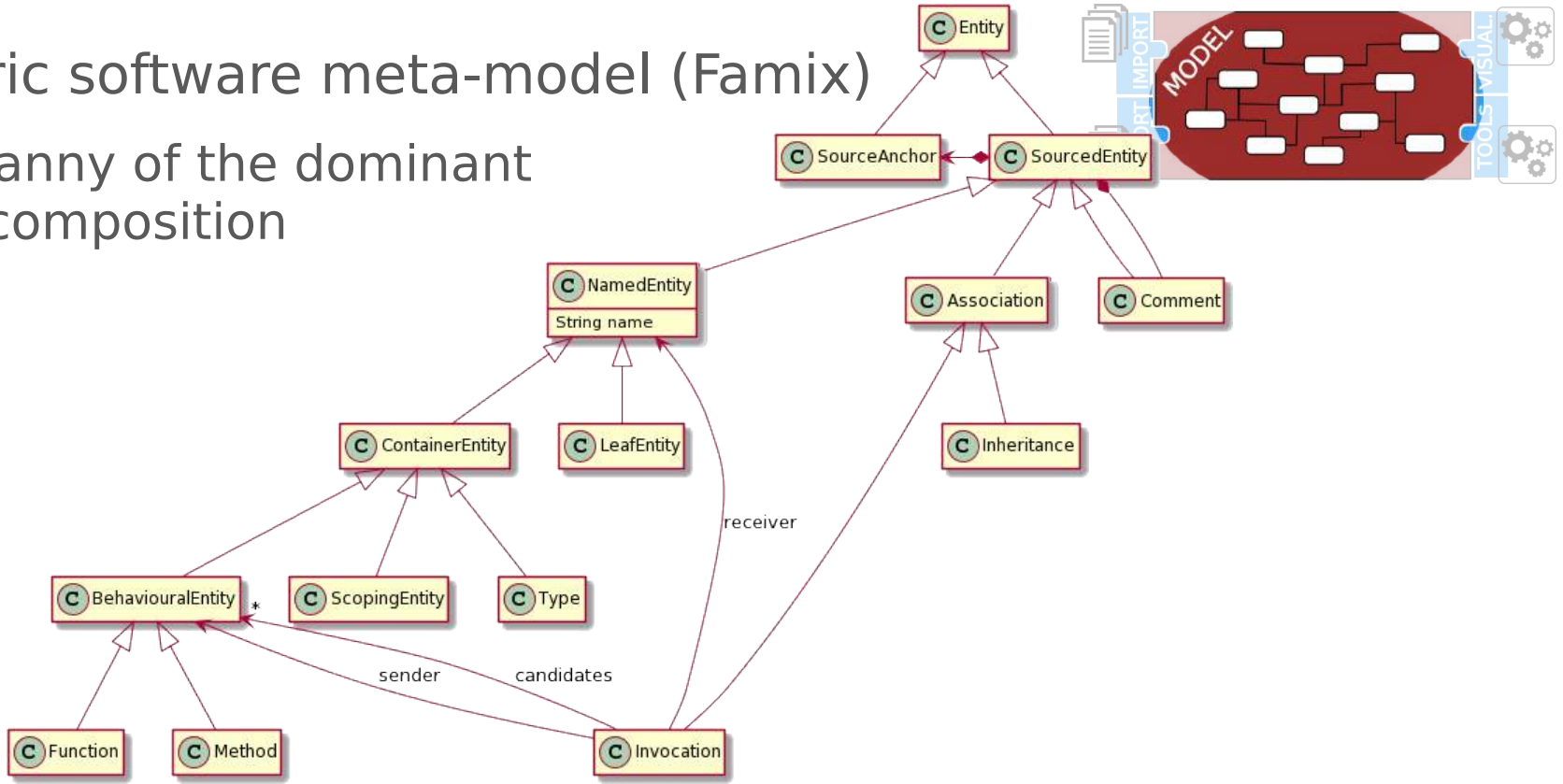




Moose, some background

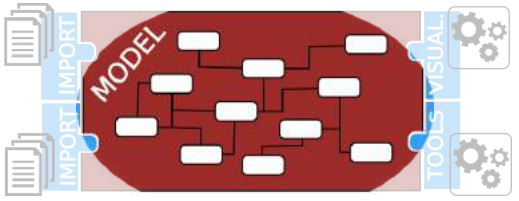
Generic software meta-model (Famix)

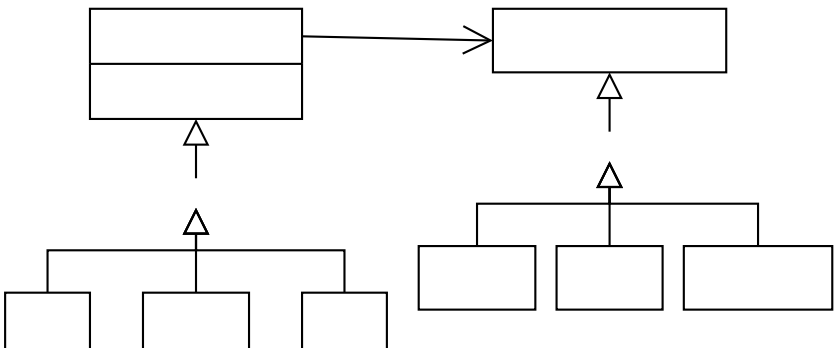
Tyranny of the dominant decomposition



Software Meta-Modeling

- Generic software meta-model
  - Dagstuhl Middle Meta-model
  - Tyranny of the dominant decomposition





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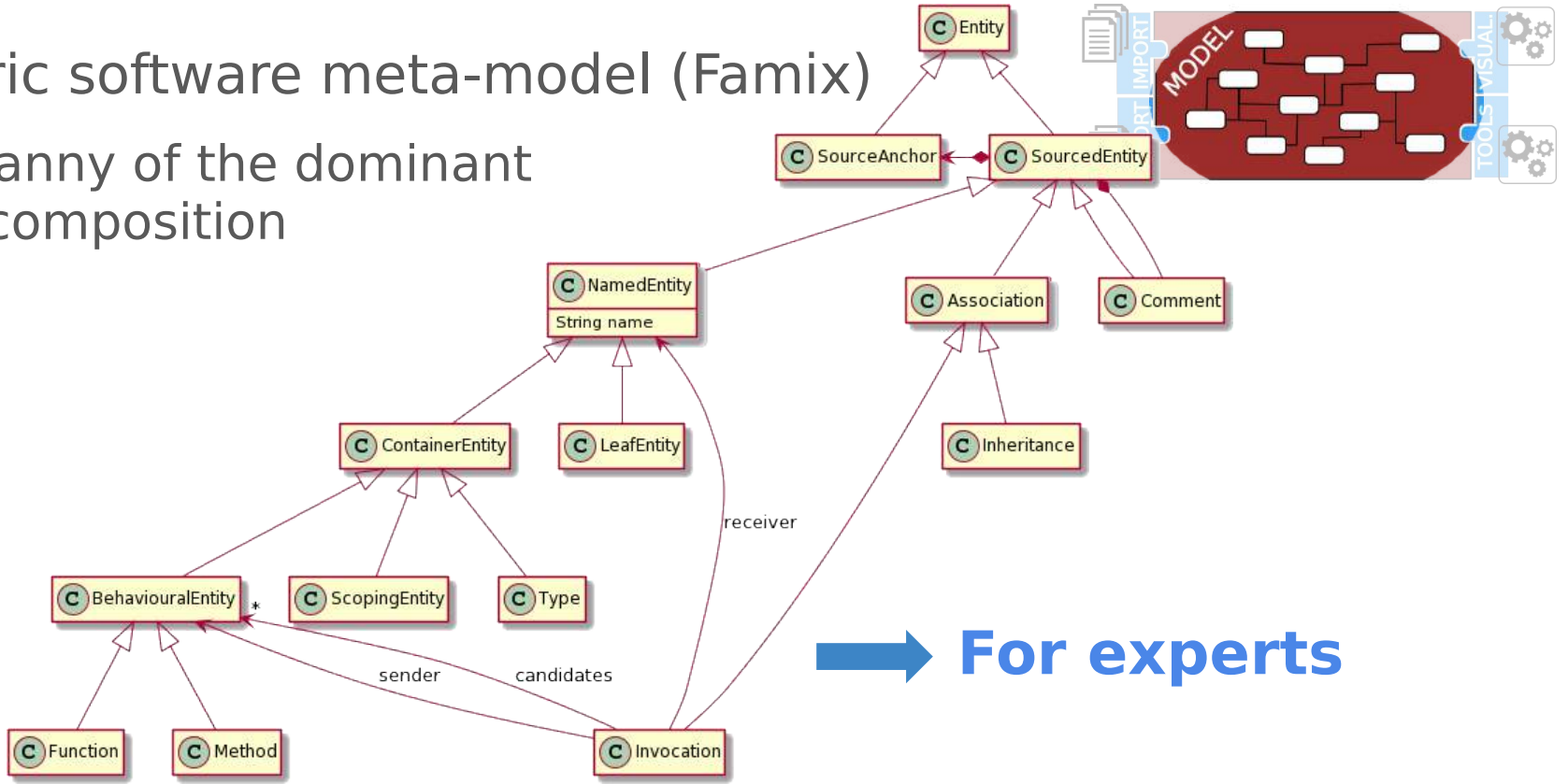

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Reverse engineering in the large/small

Moose, some background

Composable Meta-Model

Integrated Reverse Engineering Environment

Conclusion

Composable Meta-Model

~~Famix: One generic meta-model for all languages~~

Create specialized meta-model for each language

FamixNG: Bare bones entities + composable properties

Classes have *attributes* and *methods* and *inheritance*

+ *visibility* (public, private, protected, friend, ...)

+ *partial* classes + *extension* methods + use *traits*

Composable Meta-Model

- FamixNG
  - ≃ 100 traits (i.e. a set of methods that classes can *use* with a kind of “multiple inheritance”)

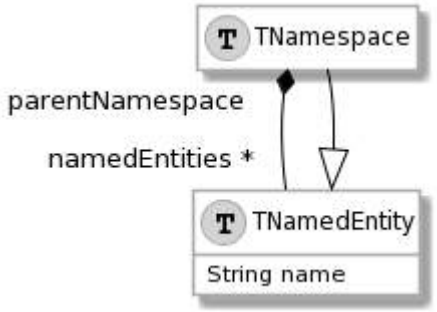
Composable Meta-Model

FamixNG

≃ 100 traits (i.e. a set of methods that classes can use with a kind of “multiple inheritance”)

Ex: `TNamedEntity` *used* by entities that have a name

Ex: `TNamespace` *used* by entities that contain `TNamedEntity`



Composable Meta-Model

FamixNG

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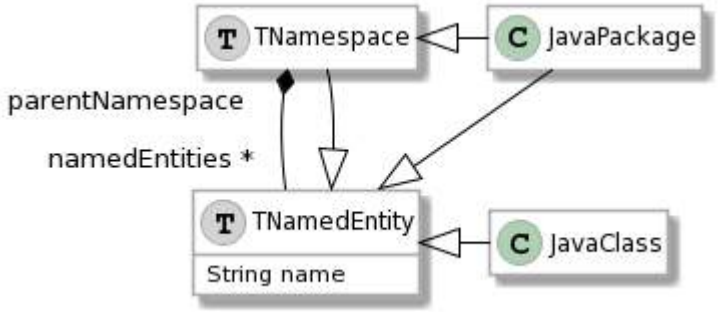

Composable Meta-Model

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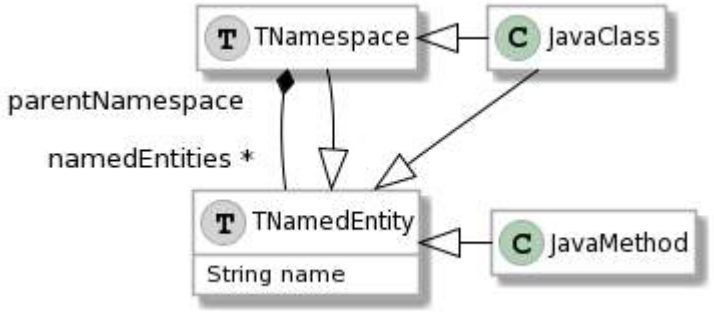


Composable Meta-Model

Generic `TClass` in FamixNG *uses*:

- `TType` (which *uses* `TNamedEntity`)
- `TWithComment`
- `TPackageable`
- `TWithInheritances`
- `TWithAttributes`
- `TWithMethods`
- `TInvocationsReceiver`

Composable Meta-Model

`JavaClass` *uses*:

- `TClass`
- `TWithVisibility`
- `TWithExceptions`

`PharoClass` *uses*:

- `TClass`
- `TUsesTraits`
- `TWithExtentions`

Composable Meta-Model

TMethod uses:

- TNamedEntity
- THasSignature
- TTypedEntity
- TWithClassScope
- TInvocable
- TWithImplicitVariables
- TWithLocalVariables
- TWithParameters
- TWithReferences
- TWithStatements

Meta-Model builder

- “Builders” to create metamodels
  - DSL (inspired by PlantUML)
  - Can import other meta-models to compose meta-models together (ex: Java program with SQL queries)

Composable Meta-Model

FamixNG

Association traits (7):
Inheritance, Access, Invocation, Reference, UseTrait, IncludeFile

Technical traits (12):
SourceAnchor, metrics, queries

Property traits(46):
name, comments, Typed, visibility, Invocable, ...

Terminal/Core/Entity traits (38):
Class, Method, Attribute, Parameter, Exception, Function, ...

Meta-Model builder

New language meta-models built from FamixNG traits library

“Builders” to create meta-models

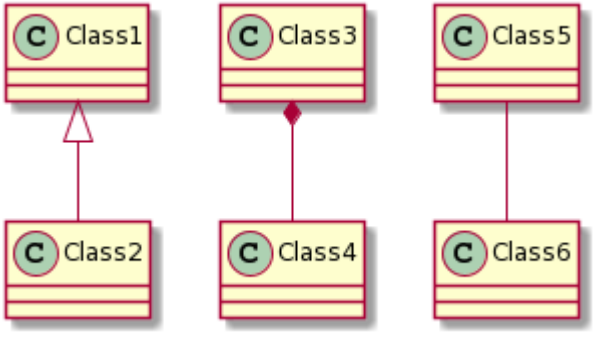
Meta-Model builder

New language meta-models built from FamixNG traits library

“Builders” to create meta-models

DSL (inspired by PlantUML.com)

```
@startuml
Class1 <|-- Class2
Class3 *-- Class4
Class5 — Class6
@enduml
```



Meta-Model builder

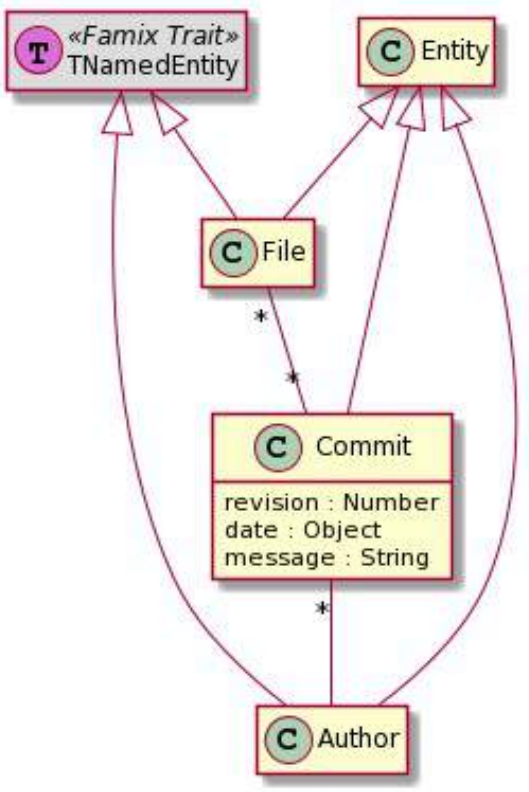
Example: Meta-model for commits

Define classes

```
entity := builder newClassNamed: 'Entity'.
file := builder newClassNamed: 'File'.
commit := builder newClassNamed: 'Commit'.
author := builder newClassNamed: 'Author'.
```

Define properties

```
commit property: 'revision' type: #Number.
commit property: 'date' type: #Object.
commit property: 'message' type: #String.
```



Meta-Model builder

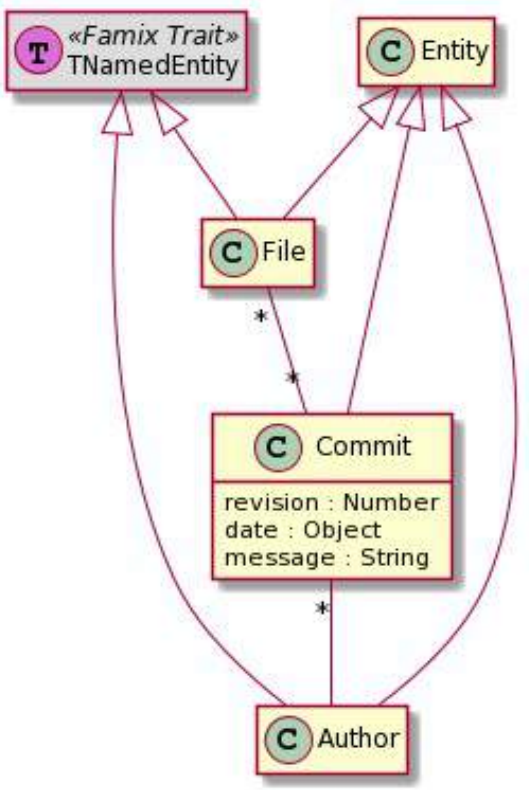
Example: Meta-model for commits

Define inheritances

```
file --|> entity.
file --|> TNamedEntity.
commit --|> entity.
author --|> entity.
author --|> TNamedEntity.
```

Define relations

```
file *-* commit.
commit *- author.
```



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Integrated Reverse Engineering Environment

Reverse engineering involves many tasks

- Visualization, query, metrics, navigation, dependency analysis, control flow/data flow analysis

This calls for many specialized tools collaborating

The tools must be generic (meta-model agnostic)

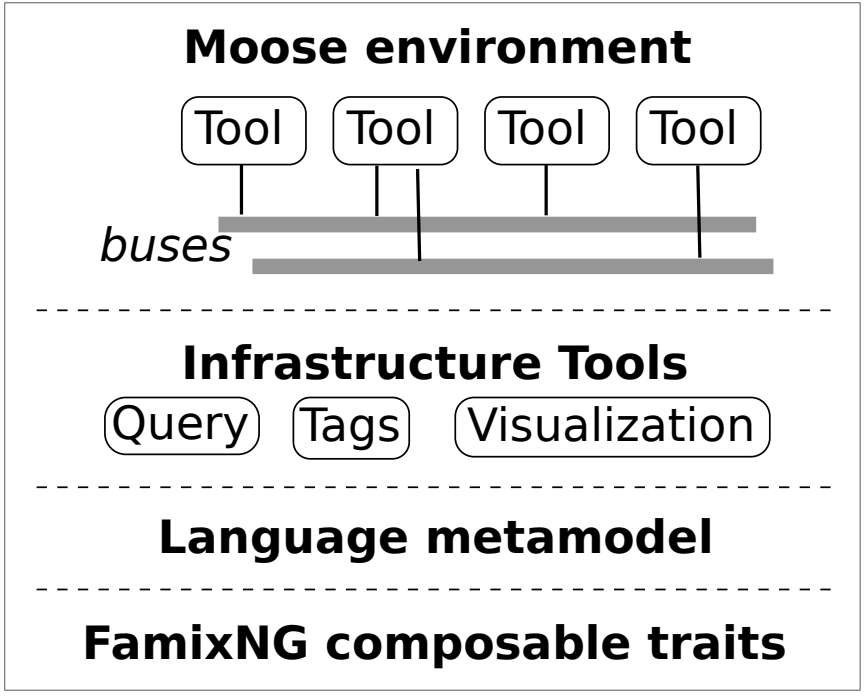
The tools must collaborate

ModMoose

- ModMoose an Integrated Reverse Engineering Environment
- IREE
  - Iree is of Hebrew origin and means: Gift of God
  - In Jamaican English, iree (or irie) means: nice, good, or pleasing; Iree is about being calm pleasant and taking life a day at a time

ModMoose

ModMoose an Integrated Reverse Engineering Environment



ModMoose

- ModMoose an Integrated Reverse Engineering Environment
  - The environment centralizes data and tool interactions
  - Tools are focusing on a single task: *e.g.*, the Query Browser works on a set of model entities and produces another set of entities
  - Tools communicate through buses, they “read” model entities on their bus(es) and “write” entities back on their bus(es)

Tools

Model Browser (imports/selects models)

Entity Inspector (Properties of selected entities + values)

Query Browser (GUI for MooseQuery)

Dependency Graph Browser (graph w/ incoming/outgoing dependencies of entities)

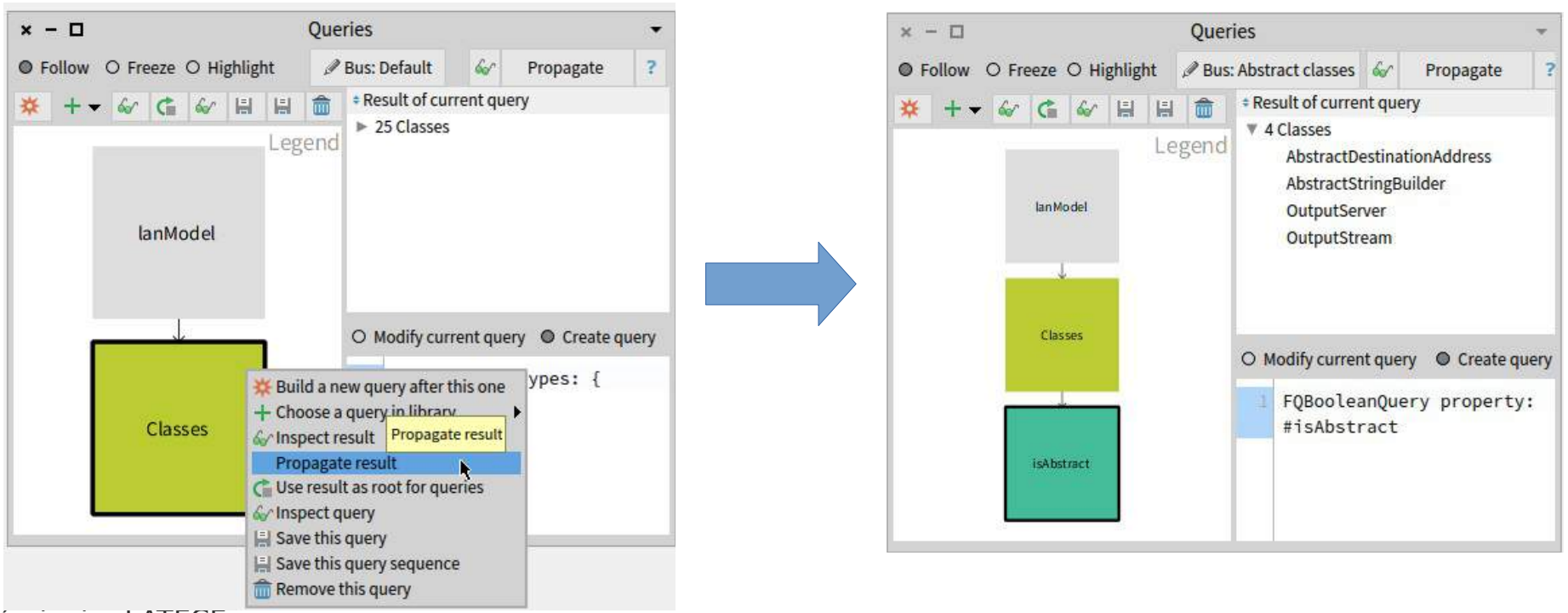
Duplication Browser (shows code clones occurances)

Source Code (Listing of source code)

Logger (Records each step with entities that pass on a bus)

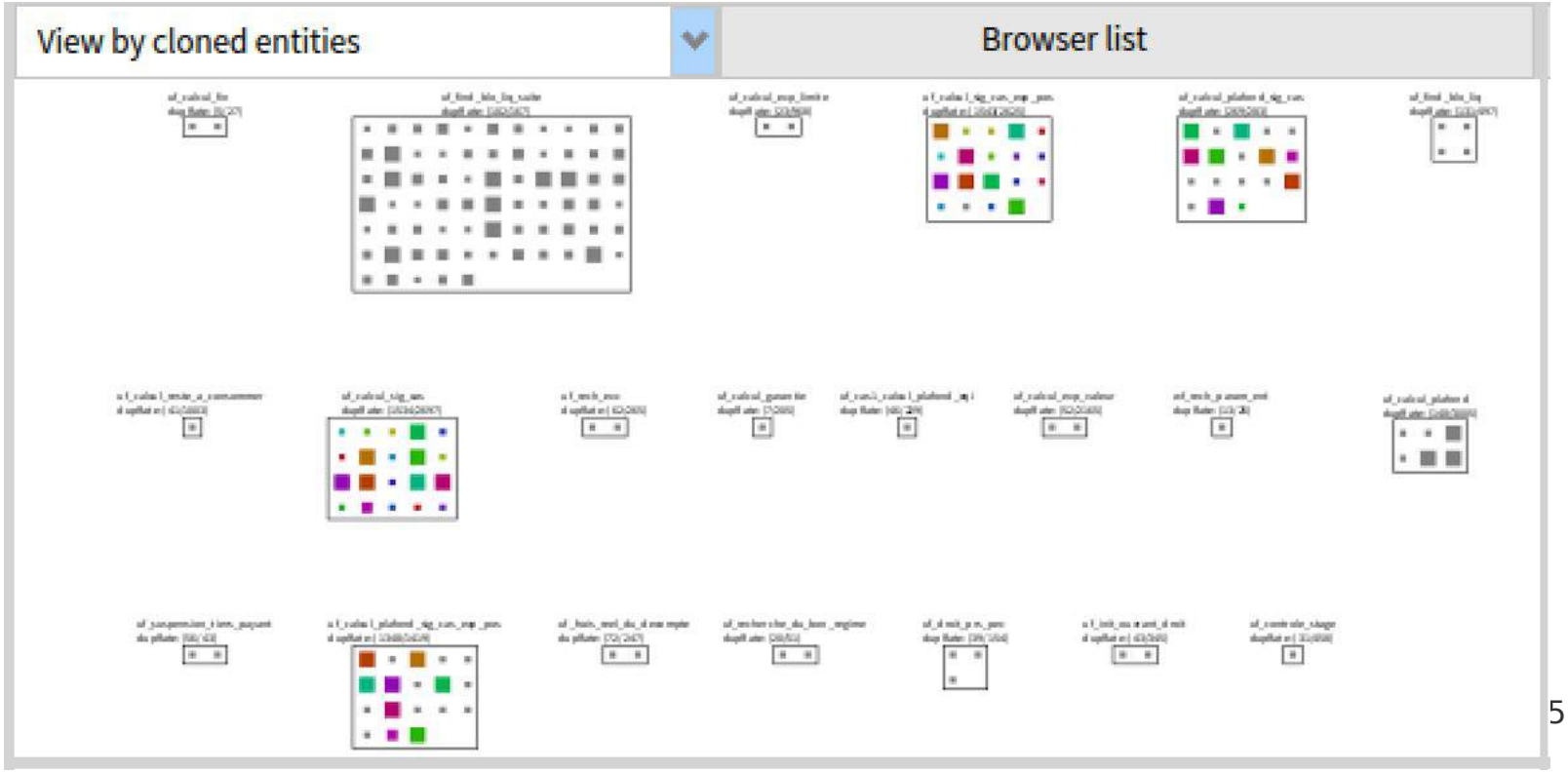
Tools

Query Browser



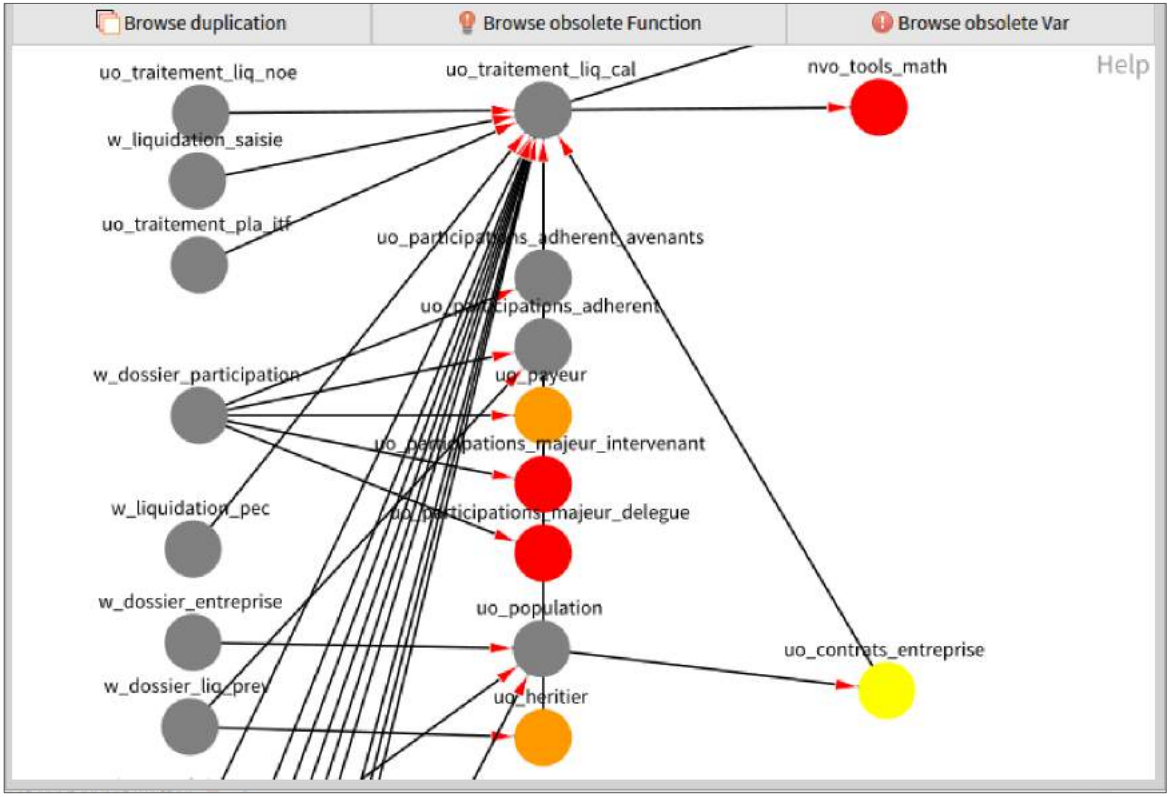
Tools

Duplication Browser



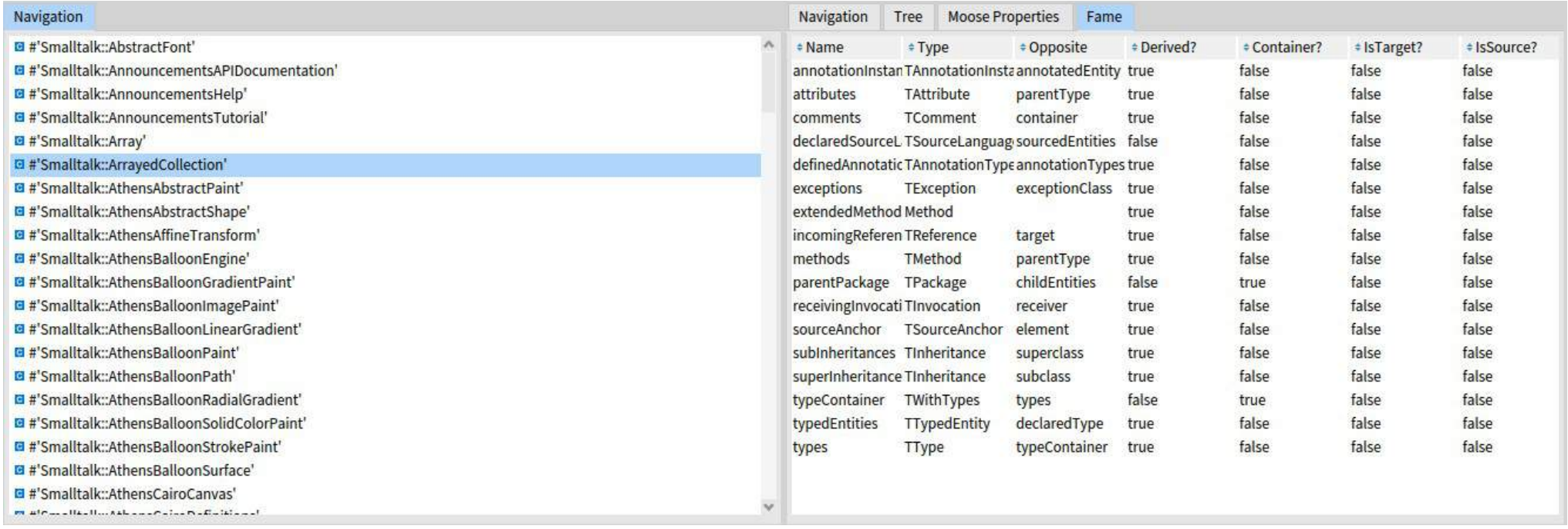
Tools

Dependency Graph Browser



Tools

Entity Inspector



Communication Buses

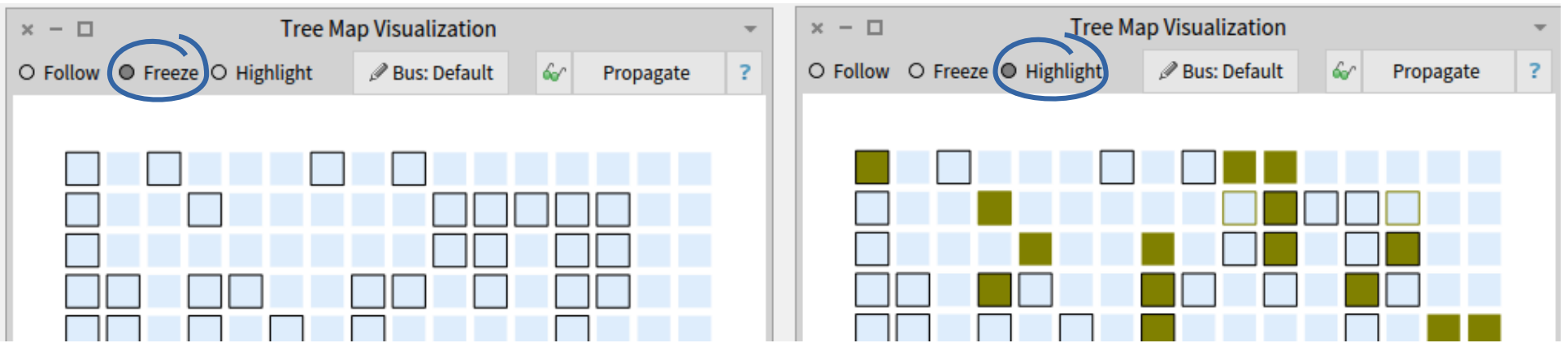
- Tools “read” and “write” model entities on buses
- Each tool can be attached to 0 to n buses
- Can have several instances of the same tool concurrently
- Ex: Compare dependencies of two set of entities
  - Bus1: QueryBrowser1 + DependencyGraphBrowser1
  - Bus2: QueryBrowser2 + DependencyGraphBrowser2

Communication Buses

- Logger tool can be set as a bridge between all buses
  - Listens to all buses (records all steps in session)
  - Forwards its activity on all buses (to synchronize them)

Tools

- Fine control of tool behavior
  - Follow: Display incoming entities, produces outgoing entities
  - Highlight: Highlight incoming entities in “frozen” display
  - Frozen: Frozen display but, produces outgoing entities



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WrapUp

- FamixNG
  - Composition of programming language meta-models from basic traits
- ModMoose
  - Interactive Reverse Engineering Environment
  - Specialized tools communicating through buses

Modular Moose

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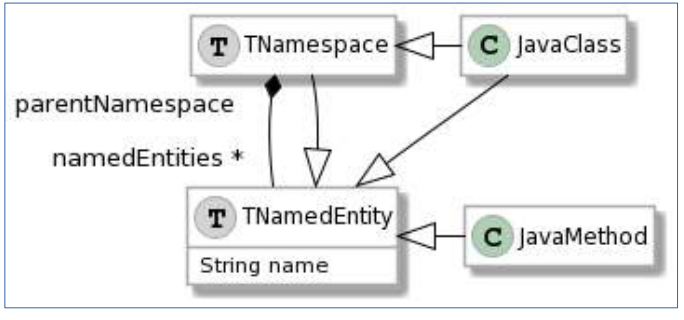

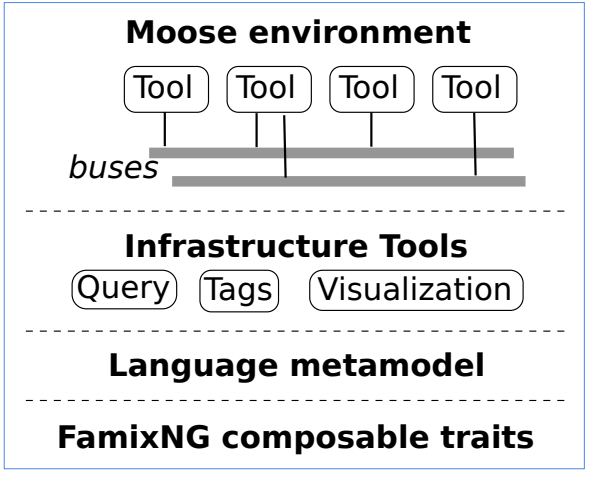

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